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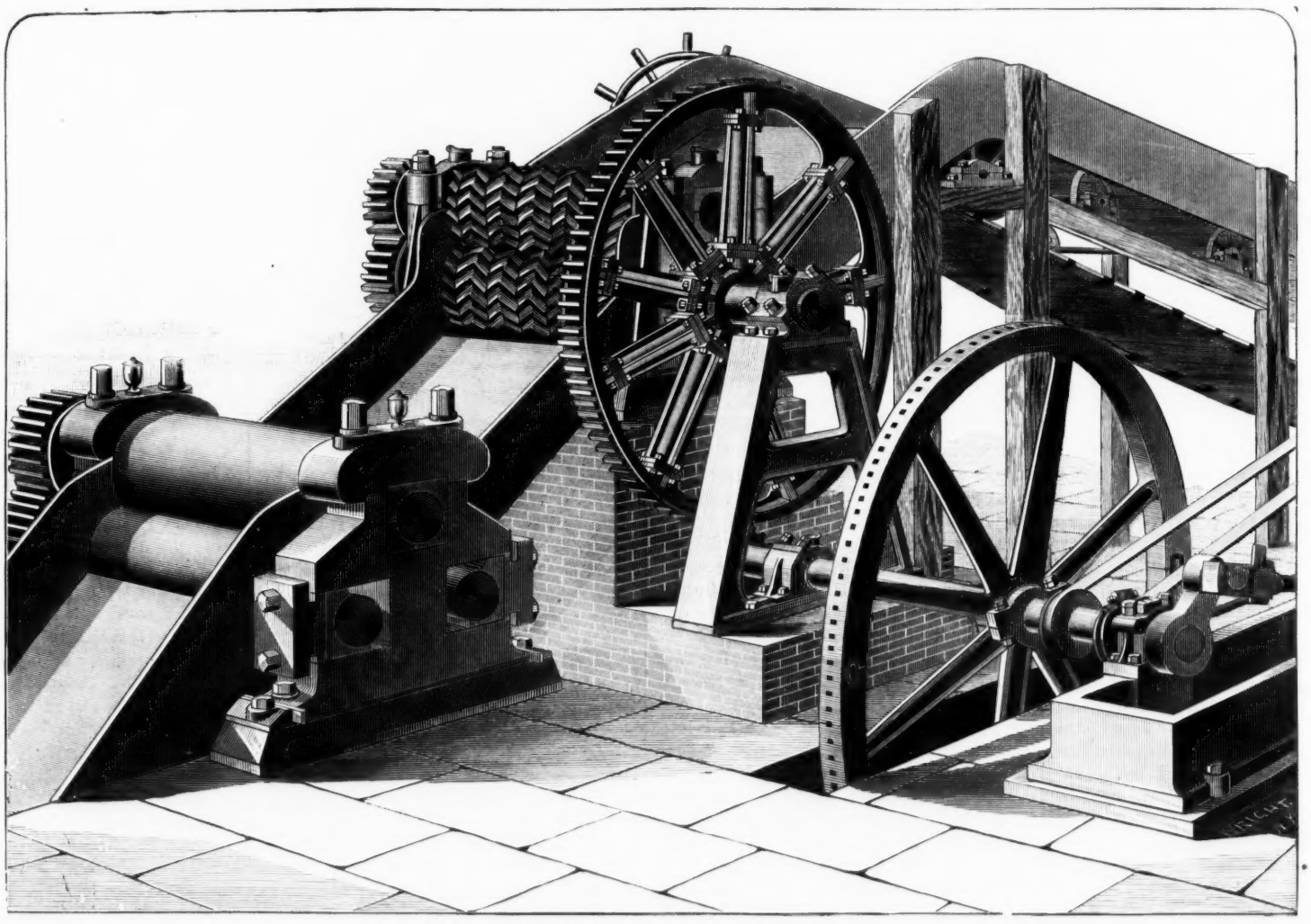
Sugar Cane Cutter and Crusher.

The ordinary way of extracting juice from sugar cane is by pressure applied by means of smooth rollers, between which the cane is made to pass. It has always been understood that, by cutting up the cane before it passes between the pressure rollers, better results as to the quantity and quality of the work performed by the mill will be obtained. Consequently, various machines for the purpose of cutting the cane have been invented. These machines are called shredding machines, and have answered their purpose with varying success.

The accompanying illustration represents a mill lately brought out and patented by Mr. F. F. Krajewski. It differs from all other machines in the fact that it combines the functions of cutting and pressing at the same time. The success of these machines is attested by the fact that they have, in a comparatively short time, found a good market in Cuba, one of the largest sugar-producing countries in the world. It has been adopted on twenty large plantations, and, from the data given to us by the inventor, the results are very satisfactory. On the plantation Union, it is claimed that 50 to 55 tons of cane are ground per hour, against 28 tons without this cutter; and this with better extraction. As high as 75 per cent. average extraction has been obtained on some of the plantations where these cutters have been used, which is claimed to be the best ever obtained in Cuba.



SUGAR CANE CUTTER AND CRUSHER.

The cutters are placed in front of the pressing rollers, as shown in the illustration, and receive the sugar cane from the cane-carriers in any position thrown off by the carts. The cutters, which are simply toothed rollers, cut it up, and at the same time squeeze out about one-half of the juice which runs through the bed of the machine, by means of a pipe, into a tank, while the cut cane or bagasse, as it is called, slides over a chute to the pressing rollers, which finish the work. The cutters do not shred the cane, consequently the bagasse is not rendered unfit for use as fuel.

The cutters are 26 inches in diameter, and vary in length from 4 to 7 feet. They are composed of solid wrought-iron shafts 19 inches in diameter at the center; on these shafts there are placed cast-steel rings with teeth in zig-zag form which form the cutters proper. The rollers are placed in suitable housings and work in brass bearings. They are connected by heavy cast-steel gears, by which motion is transmitted from the lower cutter to the upper one. The spur wheel on the lower roller engages with a pinion on the engine shaft.

The size of engines varies from 18x30 inches to 20x26 inches, according to the requirements of the cane cutter. The engines make about 32 revolutions to about 2½ or to 3½ revolutions of the rollers. Every part of the cane cutter is made exceedingly strong; in fact, stronger than is required for its legitimate work, so as to provide against stoppage or breakage, which otherwise may occur when a foreign substance, harder than sugar cane, should by accident or carelessness enter the machine. It frequently happens that iron pins or bolts find their way by some unaccountable way into the machine, and these are cut and flattened without injury to the rollers. The engines furnished with these mills are of simple design and well adapted for the rough usage on a plantation.

These machines are manufactured by Krajewski & Pesant, Brooklyn, N. Y. Their office address is 35 Broadway, New York.

Steam Boilers for Stationary Power.

BY WILLIAM LOWE.

SELECTION—CONSTRUCTION—MATERIALS AND BRICKWORK SETTINGS.

Some who read this heading may say: Boiler subject again; what more is there to say, or that can be said upon this subject? Perhaps nothing new; and if the writer thought there was no need of saying more he would let the subject rest, but his business intercourse with the users, and his contact with those who are engaged in the steam boiler business, in any respect, is constantly showing him that there is very much need of keeping the subject matter constantly before the users, and those who are seeking the best course to pursue, either as users, advisers or advocates of this mighty and indispensable vessel of water and steam, which has done so much towards the great progress of the world; and when we consider the enormous force and power the boilers of the world contain and hold, we see that the subject of steam boilers is of great and growing importance, and entitled to the most searching consideration of everything connected with them.

SELECTION.

This is the first consideration, and at the outset the searcher for the best thing, in all respects, for the requirements, must not forget that the result of the investigation depends upon his or his adviser's knowledge and ability, unbiased and uninfluenced by anything to get the facts, and properly apply them to the selection. Human nature in its self-interests, works just the same, and is influenced by just the same things, in the selection of a boiler as in the selection of other things; and in this business, as well as in other matters, it is not always the majority who are the wisest, and succeed in doing the best, because a majority of influence may mislead, and confine the majority of searchers within limits of investigation, which will make it impossible for them to get all the facts, and decide correctly, and in accordance with the state of the art and subject at the time.

The guide for the selection should be, suitability, simplicity, endurance or wear, together with steaming capacity, and economy of fuel, at the least first cost for the best, and least cost for maintenance in good working order, during the longest life.

In regard to simplicity, we all know that the makers of the most complicated boilers have a way of claiming the greatest simplicity for their boilers, and try to show it by an illustration of how easy and simple a thing it is to take them to pieces and put them together again, and repair them, and the users, or those interested, who are convinced by the argument (through inability to judge its merits), sooner or later find out that they were misled, by the interest of the seller or adviser, whose business it is to sell, what they make or offer.

Simplicity begins with the plain cylindrical boilers, without flues or tubes, and advances through the same form to those with flues or tubes, in the types of boilers known as externally fired. The first two named are but little used now, excepting for special purposes, to which they are most suitable; but the last named, under the title of the horizontal return tubular boiler, are quite extensively used in this country, and held by the makers and advocates to be equal in any respect to any other type of boiler. If this is so, it would seem unnecessary to look beyond this type, into more complication.

Against this claim we have a variety of

opinion and statements from standard authority, and published tests, to the contrary. The statement of the chief engineer of the Manchester (England) Steam Users Association, in 1876, to the Judges of Group 20, on steam boilers, of the Centennial Exposition, at Philadelphia, and published in the reports and awards that, of the 3,000 boilers then in their charge, there were none of the horizontal return tubular boilers referred to above; an astonishing statement, considering the high estimate placed upon them in this country, and coming from the pioneer country of steam engineering, where they have made, used and tested this and all other regular types of steam boilers, on both the external and internal fired principles, and now confine their use of boilers, and advice, strictly to a type of boiler which holds a higher place with them than the horizontal return tubular boiler does with us. In fact, the steam engineers referred to above will not recommend the last named boiler, except for places where there is not room for the other types referred to, which are the internally fired boilers of the several kinds used in England and her possessions, and sent by them all over the world, and now being introduced and built largely in this country, because of their superior steaming capacity, economy of fuel, and endurance. This system carries greater complexity than the other, in that such boilers are fitted with internal furnaces, and internal parts, of more or less complication; but they are accessible for cleaning or repairs, and have a wear, steaming capacity and economy of fuel, superior to any other system. This fact is becoming so well established in this country, that whereas, heretofore, a great many of both large and small steam boiler plants were of the horizontal return tubular kind, now there are many large plants of the internal furnace kind, of the several types, and others on the same principle, because it has been shown that, when the two systems are tested under the same conditions, there is more horsepower for the outlay in the last named boilers, with greater economy of fuel, and longer life, with less cost for maintenance in good order during that life, than with the other system of boilers; and that the difference in complexity is not objectionable in any respect.

The foregoing refers to the several types of what are generally known as cylindrical or shell boilers, which are the strongest and safest forms known. There are other kinds of internal furnace boilers, such as the locomotive type, and the vertical tubular boilers. The first named were formerly much used in this country, but now there are comparatively few in use, because of their greater complexity than the others, and not being so safe and reliable, on account of their form, a large portion of which must be stayed and braced, almost entirely, to resist steam pressures, and it has been found, by experience in their use, that they are shorter lived, and cost more for repairs, and the first cost, for the nominal rating, is much more than the other types named, with no greater economy of fuel. Therefore they are losing their place.

The vertical tubular boilers, with plain ends or with internal furnace has been in use many years, with varying success for large powers, but have held a place for small powers a long time, because of their simplicity, strength of form and small floor space required, and the same points hold with the larger powers of this type of boiler, and although few of large power have been used for any purpose, yet there are those who are advocating their use, and the making them of large capacity, and claiming that they are the best thing, and take up little floor space.

But there are serious defects in these boilers (for large powers), both for economy of fuel and wear, under their nominal rating to the heating surface, as compared with the horizontal types of any kind, and when forced beyond the same nominal rating of the horizontal boilers they are more wasteful of fuel.

Amongst the safety types of boilers (so called) there are many forms and constructions, both in vertical and horizontal styles. This system has received much consideration, because of the claims for safety from destructive explosions, and has gone through many changes with greatly varying results; seven of the fourteen boilers exhibited and tested at the Centennial Exhibition of 1876 were of this type. When looking in this field, the searcher will have to choose amongst the many, and, unless well posted, is likely to fail to get the best, on account of the varying construction, and the liabilities thereof, and at the same time compare the results of the use of this system of boiler with the others, and compare the money value thereof, and determine which type of boiler gives the most result for the outlay, for twenty years.

CONSTRUCTION.

All iron and steel plate boilers have a generally similar construction of like parts The riveting is generally single in the circular seams, and seams subject to least tensile strain, and either single, staggered or double riveted in the seams subject to the greatest tensile strain on the plate—such as the lateral seams—according to the pressures to be carried upon the boiler. At the beginning of the manufacture of iron plates and boilers, the plates were not made very wide, and for a long time it was considered necessary to use narrow plates for reliability and strength, for riveting in the edges. For many years no plates over 24 to 30 inches wide were used; but now plates are made up to 100 inches wide, and used with satisfactory results. In my experience, very wide plates of iron or steel are more liable to crack through the rivet holes, at the edge laps, than narrower ones of the same quality, when placed over or subject to the heat of the fire.

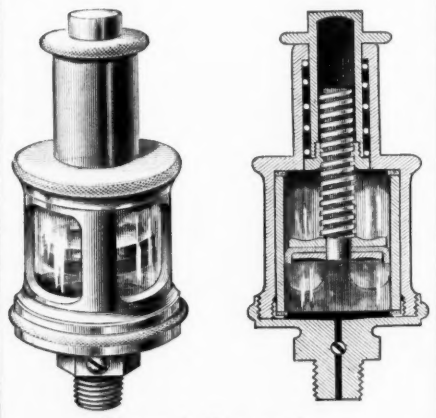
The improvements in working, handling and rolling the blooms and ingots or slabs, for iron and steel plates, are such that very wide and reliable plates are now made and used, and to all cylindrical, external furnace boilers they are beneficial, in that there may be no laps over the furnace, and fewer in contact with the strong heat of the fire; but to what extent the stiffness of the shells is reduced, and also its strength and safety, by less circular laps, in the whole length of the boiler, is a question for consideration. In the furnaces of internal furnace boilers it is advisable to have as few laps as possible, but very long flues or tubes should be stiffened with either rings or laps, and the long shells with laps.

The bracing and staying of the flat surfaces, crowns of furnaces and water spaces (circular or flat), is of the greatest importance, because these parts depend almost entirely upon the reliability, quantity and quality of the materials used, for safety, and it should be remembered that provision in quantity should be made to carry the boiler through the wear of a reasonable length of life, without necessitating much reduction of pressure on account of the reduction of thickness of plates, stays, braces, socket bolts and sockets, by wear, from any of the several causes in the use of boilers. No claw braces or stays with pins, or bolts, should be used in any part of the construction of a boiler where they can be dispensed with. The bracing and staying should be solid; each brace or stay should be fitted into its place, and solidly riveted to the plates.

The use of tee-iron for staying or bracing by claw, with pin or bolts, should be abolished, because it is not reliable, and obstructs the circulation of the water and steam over the surfaces of the plates mostly exposed to the highest heat of the fire, and places them in jeopardy from the effects of this heat, and is absolutely dangerous to boilers using water which forms any scale. Screw stay bolts should be very nicely fitted to the tapped holes, which should have very nearly a full thread and be screwed tightly into holes opposite each other; socket bolt stays should have thick wrought-iron sockets, each fitted to its place solid, and the holes true with each other, to make good reliable work. A boiler of any kind, well built in this way, with best materials, will be reliable, and give more satisfaction under any conditions of use than any other, and will stand much more abuse, without accident. I have never known a boiler built in this way explode, excepting under very extraordinary conditions, which no inspection could prevent. In fact, most of the boiler explosions are caused by weakness in either the construction or the materials, or both. Therefore the greater necessity for this thorough and reliable construction of steam boilers.

MATERIALS.

It is folly to use any but the best and most reliable plates for the several parts of a steam boiler. Those for the furnaces and bottom plates over the fire should be of best warranted fire-box iron or steel, and all other parts subjected to the heat of the fire should be of reliable, well-proven brands for these parts, and all other parts, not exposed to the heat of the fire, should have sufficient ductility, strength and stiffness to outlast those parts which do the work of evaporation in the boiler. For boilers to carry extraordinary pressures, the plates should all be of the same tensile strength and ductility, and of a thickness that will give a reliable factor of safety for the pressure to be carried, and a liberal allowance for wear. The rivets, socket bolts, screw stay bolts and the iron for braces and stays should be of the best and most reliable quality and here I venture the assertion that a very large portion of boiler explosions are caused by poor, unreliable materials for the bracing and staying, as well as the plates for the boilers. These statements may be taken as a matter of course, and quite unnecessary; but when a mill owner is obliged to ask whether an order for plates are for use in



Benner's Grease Cup.

steam boilers, to protect himself from consequences that may happen by using plates which should not be put into boilers, it is quite necessary for some one to protect the buyer from the consequences of unscrupulous makers of boilers, and the buyer's disposition to buy at the lowest prices. There is no business transaction in life which requires more scrupulous honesty than that between the buyer and the maker of a steam boiler.

BRICKWORK SETTINGS.

This part, although quite simple for both externally and internally fired boilers, has been done in many ways, all intended to improve the economy of fuel and endurance of the brickwork. The setting of a boiler should never be put into inexperienced hands, nor in the hands of one who is not a good mason and fully posted on the requirements; the very best fire-bricks should be used, and common bricks also, and laid in as little mortar (of best quality) as possible, so that the bricks will cling to each other, and prevent cracking. The walls should be thickest where exposed to the greatest heat, and either double, with air space between, or solid of same thickness. If double with air space between, there should be no inlet or outlet to said space for circulation of air (as some arrange it) which would carry off heat, and waste fuel, and frustrate the object of the thick walls, especially if the inner wall cracks, which will surely happen in the majority of cases, and so will the outside wall, in as many cases as the solid wall. The solid wall without the air space is, I believe the best, of equal thickness with the double wall, and a better job can be made of repairing the furnace or other parts, with the solid walls.

Care should be taken to have no interference of the brickwork with anything attached to the boiler that would permit the expansion of the boiler to carry the brickwork apart; this is the principal cause of cracks in the walls. The closing of the return at the back end of boiler should always be made with a cast-iron plate fastened to the boiler head, with freedom for expansion over the rear wall, and the end coverings should be of the same character. The supports for carrying the boilers should be a cast-iron bracket on each side, near the front end, which should rest upon plates laid on the wall, and the brickwork set clear of the brackets, so that the expansion could not interfere with it. The back end of the boiler should always be supported upon a solid, substantial pier, and the expansion carried by a double saddle, with a roll between, set into a groove, to prevent its getting out or swerving. The furnace, being the most important part of the setting of an externally fired boiler, should be well done with the best fire-bricks with several header courses, to facilitate repairing in good shape.

The bridge wall should be as thick and substantial as necessary, to resist the action of the fire irons against it when working or cleaning fires; the top of it should not be circled, but should be straight across both ways, and not less than 9″ below the bottom of the boiler. The space underneath the boiler, beyond the furnace, should be not less than two feet below bottom of boiler; more would do no harm to the economy of fuel; no need of masses of expensive brickwork of curved or other form to lead the currents of the gases, because they will take the highest spaces, and will impinge upon the heating surfaces of the boiler, in their own natural way, no matter what the space is beneath the boiler, or the shape of the floor, nor will there be any difference in the economy of fuel, from one foot to four feet of space under the boiler, in my experience.

The covering over top of boiler should be two courses of bricks upon edge, the first course laid in fire mortar, and the outside course in lime mortar; or the covering may be of any good and suitable non-conducting material of sufficient thickness to prevent radiation of heat.

THE GRATE.

This is of great importance, and should have a distance from the boiler according to the kind of fuel to be used. For anthracite coal it should be from 18 to 21 inches; bituminous coal 24 to 27 inches; and for light, bulky fuels, from 27 to 36 inches. It should be level in all cases, and should be short and wide, rather than long and narrow, because it is easier to keep the fire in the most economical working order on a short, wide grate, than on one long and narrow, of the same square feet of surface.

Finally, those interested in any way in the buying or using a steam boiler must not forget that they can always buy more of an inferior article or kind for the money, and that the turning point in the deal is whether they can be persuaded that they can buy enough more of the inferior kind for the money, to equal in any respect the result of the outlay in the very best kind and quality.

Benner's Grease Cup.

Lubricating oils have been, for many purposes replaced by various grease compounds, and, where arrangements are made for properly feeding the grease to the bearing, good results have been obtained.

With this we give illustrations showing the construction of the latest device brought out for this purpose.

It is a cup, the base of which is screwed permanently into place, the cup proper being screwed into the base in the manner shown.

The glass consists of a section of glass tubing, which is cut to proper length, the ends ground and packed at each end, as shown in the sectional view, a threaded ring at the bottom holding it in place. Inside the glass is a piston packed as shown, and which rests on top of the grease, forcing it downwards by the action of the spiral

spring, which rests upon the nut fitted to the threaded stem of the piston.

Adjustment for feed is made by simply turning the cap at the top.

The cup being filled with grease, the piston cannot descend, but, instead, the nut and sleeve to which it is attached rise, compressing the spring, which, by the pressure it exerts upon the piston, forces the grease slowly through the stem to the bearing, the rate of feed depending upon the amount of opening given to the small plug cock shown in the base. In filling the cup, it is only necessary to unscrew it from the base, turn the cap until the piston is at its highest point, put in the grease, and replace the cup; a few turns of the cap at the top then put it in condition for feeding, the distance the cap raises above the shoulder indicating the amount of grease which will be fed before requiring further turning of the cap. No disturbance of the feed is required. As will be seen, the cup is very neat in appearance, simple, and thoroughly excludes dust and dirt. It is made by X. X. Benner, Elizabeth, N. J.

The Practical in Self-oiling Bearings.

By Jarno.

Waubug Mephit thinks Gascon, in the American Machinist of Jan. 16, is severe when he says that self-oiling bearings should have a nurse. Gascon did not say that every one should have a nurse, but only those whose condition cannot be readily seen.

The saying that, "By trying the impossible, we may achieve the highly difficult," is repeated rather as an opiate after failure than as a stimulant before attempt. The attempt to make a bearing that will really oil itself under varying conditions has so often ended in failure, that we must conclude the accomplishment is not easy. In this paper I purpose to note some of the conditions that may cause failure, and also some of the remedies for these conditions.

Generally, self-oiling bearings take oil to the shaft from a well or chamber, which is filled once in a term of months or of years, according to the watchfulness of the attendant, or the endurance of the bearing. In some kinds of bearings the oil, in getting to the shaft, must go through a fibrous or spongy conductor that rests against the shaft, as at *C*, Fig. 1. In other kinds, the oil is pumped up by the friction of the shaft, or it may be lifted by a chain, or by a ring, or by a wheel. Then we have a kind in which the shaft brings oil down upon itself by joggling a wire; and still another, in which a solid lubricant is put over the shaft, and is melted and converted into thin oil as required. In Fig. 2 there are both the joggle wire and the solid lubricant.

Bearings having projecting shoulders like Fig. 3, as in propeller shafts, thrust bearings, and bearings upright, as in Fig. 4, both of which reach down into a well, as it were, are not strictly self-oiling, but oil-holding bearings, a box itself being its own well.

Mr. Geo. R. Babbitt showed me two lines of shafting running satisfactorily in self-oiling bearings that are cleaned and filled every six months. The bearings are of the chamber and wool variety. One line has cast-iron boxes, and has run for twenty-two years. I asked him why it was that he did not apply self-oiling to machine tool bearings, and to the bearings of his steam engines. As his answer is based upon his own observation and practice, I give it entire.

"In most line and countershaft bearings, the pressure is comparatively light, and the boxes have a loose fit, resulting in not pressing the oil out, and in giving it room to circulate.

"In a machine tool we cannot have a spindle fit its box loosely enough to give oil the room required for self-oiling circulation; we cannot spare the room for a device to catch the overflow, and, moreover, it is not well to use the oil again and again unless cleared.

"Still more do the conditions limit us in our engines. Every safeguard must be thrown around an engine to keep it running as long as wanted. That it never stop on account of hot bearing is imperative. If once a bearing be roughed, the engine has a diseased and tender part ever after; there is no cure but to replace one piece, and take the bad surface from another. The pressure per square inch upon engine bearings is necessarily heavy; while we must guard against having it heavier than safe, yet, in so guarding, we cannot much increase the size of the bearings, because any increase, after reaching a good safety area, adds excessively to the size and consequent weights of the parts.

"The crank-pin being overhung, an addition to its length may cause so much increase of area pressure, in some places, by lengthening the leverage of overhang, that on the whole there is no gain.

"Similarly, the bearing area cannot be spared to give place for wool.

"In our engines a pressure of not more than two thousand pounds to the square inch is safe.

"If, while the engine is running, a spot on a bearing gets dry, in a few minutes the heat that was under the boiler reappears as a destroyer, and in a few more minutes the engine must stop. The only safe way to avoid trouble is to be able to tell at any time whether the bearing is being oiled; for this

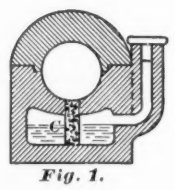


Fig. 1.

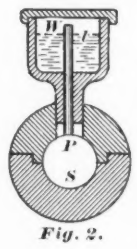


Fig. 2.

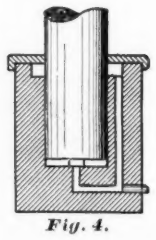


Fig. 4.

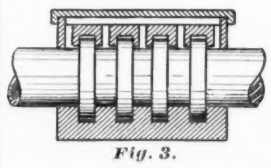


Fig. 3.

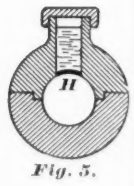


Fig. 5.

Self-oiling Boxes.

we have sight feeds. As soon as a particle of metal is abraded in the bearing, it should be taken out; to do this, clean oil should be fed in. We can again use oil that runs out, but only after it has been strained, and then allowed to settle for months."

Mr. Babbitt clearly points out some of the limitations of the use of self-oilers. In Fig. 2 there was another limitation which Gascon paid dearly for learning. It will be remembered that, in Fig. 2, a solid lubricant *l* is put over the shaft *S*, and is melted down by the heat of the shaft, or is joggled down by the wire *W*. Several lines of shafting, whose bearings have this device, are running satisfactorily, being filled with the solid lubricant once in about two weeks. The engineer in a building, in which there are two lines more of the same kind as Fig. 2, reported that he was using too much coal, and that, not finding any trouble with either his boilers or engines, there must be something that was using up too much power. The matter not receiving the attention that he thought it deserved, his reports turned into complaints; yet but little notice was taken of them, and still less investigation was made to see if they were reasonable. He persisted. At last, in sheer desperation, the superintendent himself made an examination of the hangers and soon found the trouble—the same that has been the annoyance and dread of men since the time when first a man, in seeking to know, found disappointment. It was dust. The shafting drove wood-working machinery, and wood dust had collected and formed a stopper over *P* and around the wire *W*. In the same building was another shaft, Fig. 5, with two large holes, *H*, over each bearing. Into these holes the solid lubricant or grease had also been put, with the idea that it would run down as wanted, if a bearing should get hot. The bearings of Fig. 5 were in a worse condition even than Fig. 2, caused by dust plugs that had formed over *H* Some of the bearings were so hot that the lubricant had melted into thin oil, and yet the dust plugs were dry and glazed underneath, because they were so tight that no oil could get to the bearings. When the holes were cleaned and fresh oil put in, the engineer at once noticed a change in the power required to drive. A mixture of oil and wood dust is not a lubricant. The bearings are now oiled every day, and the holes are cleaned every week.

Any fibrous conductor, *C*, Fig. 1, will in time get glazed, and the oil cannot go through. The problem should be either to scrape off the glazing or put in new conductors and oil, before the bearings are dry. Three users tell me that they let the bearings go until there is either a squeak or a smoke; this being, on the whole, the more economical. This cannot be a deliberate practice; the statement is made rather than to acknowledge neglect.

Unwin objects to self-oiling pedestals because they require a large supply of oil at first, which gradually becomes viscid and useless.

An endless chain running over a shaft, and down into a well, is an effective way of oiling; its weakness is that the chain is soon worn, as many as three having been worn out by a single bearing of a quick-running shaft, in one year. The chain also keeps wearing a groove, deeper and deeper, into the shaft.

Augustus Newell & Co. were my informants in regard to the device for upright shafts, Fig. 4, in the American Machinist of Jan. 16th I varied from their drawing and made the outlet oil channel near the top of the box instead of near the bottom. In doing this they think that I made a mistake, because oil works its way upward better than downward. They improved this device, and have used the improvement for many years. My idea was to make a circulation by leading the oil down in a groove after delivering it near the top.

Self-oiling spindles have run for months without giving trouble. Still, as Gascon says, they are like some men—they never let it be known that there is anything the matter until they are very warm with their dissatisfaction. Then we find that there has been friction rankling for a long time. When a bearing does refuse to work it is at a time when we can ill afford to stop to repair. The man that does not let his dissatisfaction be known until he is so mad that he can no longer hold in, is hard to get along with; so with a bearing whose condition cannot be known until it stops.

It would appear that the conditions of work and fail are as nicely poised in a self-oiling bearing as in a stylographic pen. Just here Waubug cries a halt—"No comparison between the two; the pen is seldom a convenience—often a nuisance—always a care." It is a failure because he cannot make it go. There is but little hope that Waubug will ever indulge in less of this kind of non-reasoning, which is happily not common among mechanics. The success of a man's use of a thing is made up in some way of his skill and the thing's merit; Waubug has associated his own lack of skill with lack of merit. When filled with thin oil, the principle of Fig. 2 does not much differ from that of a stylographic pen. No doubt the pens could be used for oiling bearings.

However excellent a labor-saving device, it must be attended to some time. Whether or not we have bank examiners, bell punches, self-oilers or self-adding cash registers, we must have reliable men. In our improvements let us not forget men.

Electrical Executions.

Now that it has been decided by the Court of Appeals that the infliction of the death penalty by electricity is constitutional, we seem in a fair way to be able to judge of the "degradation of the noble science," etc., which many, and more especially some of our electrical journalistic contemporaries, seemed to fear. A persistent and strong fight was made against the carrying out of the law, and it is very certain that those who have deemed it to be to their interest to mystify the subject, and make it appear that a dynamo could not be made a certain instrument of death, are now in much worse plight than if they had kept quiet and avoided the commotion, which can only serve to attract the more attention, and unfavorable comment. It is now to be expected that we shall hear all sorts of absurd stories regarding the failure of the apparatus; and there is little doubt of the appearance of the mysterious but always convenient "reliable informant," who has seen the criminal alive and well, more than a month after the execution was alleged to have taken place.

The task which was undertaken—that of persuading the people through the medium of the courts, and by expert evidence, that dynamos are harmless—was too great to succeed; but it is perhaps fortunate that it has gone to the highest court and been definitely settled. There was a time when people could be convinced against the evidence of their own senses by expert testimony, but that day has gone by, and it is just such expert testimony as was presented in the Kemmler case, which more than anything else has brought it into disrepute. We do not believe that any one who knows anything at all about electricity has the least doubt but that it can be made to kill certainly and instantly; yet an effort was make to make it appear doubtful, by the testimony of "expert electricians."

It will be remembered that some time ago there was considerable discussion in our columns, of the value of the anvil principle as applied to machinery for the absorption of vibration. A good example of this is now to be seen at the new sugar refinery of Claus Spreckles, at Philadelphia. The engines are distributed pretty much all over the building, some of them being on the upper floors, bolted to iron beams or girders. Some of the engines ran all right from the first, but others set up considerable vibration. To correct this, foundations were placed under them, but, instead of being bedded in the earth, as usual, they are simply suspended in the air; and, instead of the foundations supporting the engines, the engines support the foundations. The result is all that could be desired, the additional weight absorbing all vibrations, and causing the engines to run quietly and steadily.

Mr. John J. Grant sends us a photograph of a conical shot made by the Simonds process of rolling, for a Driggs 6 lb. gun. The photograph was taken after the shot had been fired by Mr. Grant through 4" of armor plate, and it appears as perfect in shape, and with the point as sharp, as before it was fired. The writer saw at the works in Fitchburg, specimens of steel plate, into which steel bullets had been fired from a shoulder arm. The plate in some instances was of such a thickness that the bullet failed to quite go through, but remained firmly wedged in the plate, with the point projecting slightly, and, so far as could be seen, entirely uninjured. It is claimed that the best shot in the world are now made by this process.

An English contemporary mentions the instance of a new large steam engine that gave trouble from a hot crank-pin. Finally the engineer in charge measured the pin, and found it one-sixteenth of an inch oval. The journal referred to remarks: "It is easy to see that the lathe in which the pin was turned was in fault. It is quite likely that the turner was more or less incompetent." One-sixteenth of an inch oval! We do not believe the conclusions arrived at can be successfully questioned.

The Friction of Ball Bearings.

By Fred J. Miller.

The opinion is quite common among mechanics, that, by the use of ball bearings, sliding friction is entirely avoided, and that in such a bearing there is no other than rolling friction.

From this idea arises the notion that such bearings should require no oiling, though, as a matter of common observation, oil is necessary in nearly all cases. And even among those who recognize the fact that there is sliding friction, there are those who fail to recognize what may, I think, under some circumstances, be its chief cause.

The fact that the balls rub against each other in revolving, and cause friction in that way, is generally recognized, but there is probably another cause not so generally recognized, and which is the result of the compressibility or elasticity of metals.

If a hardened steel ball, such as is used for ball bearings, be held about a foot above the hardened steel surface of an anvil, and dropped upon it, it will rebound nearly to the height from which it was dropped.

This it does by reason of the elasticity of the ball and the anvil, the one being slightly flattened by the force of the blow, while the other is slightly indented, the force exerted by them in returning to their original forms furnishing the power of reaction by which the ball is thrown upwards. If the ball were simply laid upon the surface of the anvil, and rolled about, it would meet with practically no frictional resistance, except that of rolling friction, and if the ball and anvil be very smooth, there will be very little even of that; and oil, instead of facilitating its movement, would be an actual hindrance to it. But if, while it is being rolled about, it be at the same time pressed upon the face of the anvil with the same force as was exerted by the blow when it was dropped upon it, the anvil will be indented, and the ball flattened to the same extent, and an appreciable frictional resistance will be encountered.

The intensity of the pressure sometimes imposed under such circumstances may be very great, and a little consideration of this pressure may help us to realize the fact that a sensible yielding must take place.

If no yielding did take place, the contact of the ball with the surface would be upon a mathematical point only, which would be without magnitude or area. Simply the weight of the ball itself would then give an infinite pressure per unit of area; proving at once that some yielding must take place, even under the lightest pressure.

Take the case of a ball bearing having $\frac{7}{8}''$ balls, each loaded with 100 pounds, and suppose this weight causes yielding to such an extent as to make a bearing of the balls upon the surface on which they roll $\frac{1}{10}''$ in diameter. The pressure per square inch of surface in contact will be 12,820 pounds. I have a blue print of a thrust bearing, designed by a concern which has had an extended experience in this line, in which there are 207 $\frac{7}{8}''$-balls, each sustaining a weight of 280 pounds. Supposing the yielding to be the same as before, the pressure in this case would rise to 35,896 pounds per square inch, which is very near the elastic limit of tempered steel, and probably nearer than it would be practicable to go, and have things work well. In other words, it is likely that the yielding, in such a case, is sufficient to get a bearing somewhat more than $\frac{1}{10}''$ diameter.

All the yielding in such a case is not, of course, done by the ball, but, on the contrary, some experiments which have been made show that the ball yields considerably less than the surface upon which it rolls, and thus sliding friction is introduced, from the fact that different portions of the ball, having different surface velocities, are in contact at the same time.

At Fig. 1, a smooth, hardened ball is supposed to rest upon a smooth, hardened surface without pressure, and to roll over it, its axis of rotation being the line $A\ B$. In such a case there would be no yielding; the ball would touch only on the line $C\ D$, and there would be no sliding friction. But now suppose the ball to be placed upon a surface of softer material like lead, into which it is pressed, as it is revolved (Fig. 2), its axis of revolution being $A\ B$, as before. The ball now touches the surface, not only on the line $C\ D$, but at the lines $C'\ D'$ and $C''\ D''$ as well, and at all points between them.

Supposing the ball to be one inch in diameter, if it were in contact with the surface on the line $C\ D$ only, it would move during one revolution, a distance equal to its circumference, or 3.1416″. The lines $C'\ D'$ and $C''\ D''$ are about .65″ long, and if the ball touched the surface at these lines only, it is evident that it would be moved during one revolution a distance equal to the circumference of a circle of this diameter, or 2.042″.

As it is evident that the ball cannot move both these distances during a revolution, there must be a slip somewhere, and it will be equal to the difference between 3.1416″ and 2.042″, or 1.099″ per revolution.

In this case we have supposed the ball to retain its form, not being flattened at all. Under ordinary working conditions, the surfaces on which the balls roll are not indented, of course, to anything like the extent shown in Fig. 2, and instead of the surface doing all the yielding, the ball does some of it; or, in other words, is flattened to some extent.

But this yielding of the surfaces in contact always takes place to a greater or less extent under working conditions, and, together with the fact that the balls usually rub one against the other as they revolve, accounts, it seems to me, for the fact that oil is necessary, and that cutting takes place unless it is applied.

Warner & Swasey, in constructing the Lick telescope, substituted for the balls, hardened and ground cylindrical rollers in the principal bearing, thus entirely avoiding this cause of sliding friction, and, by keeping the rollers slightly separated, avoiding the other cause referred to.

Their method of keeping the rollers separated was by providing ball bearings at each end of each roller, the balls running in recesses provided for them in a loose ring, which passed around the bearing at each end of the rollers. Yielding of these rollers, or of the surfaces upon which they bear, does not bring about contact of surfaces having different velocities at the same time, as shown to be the case with balls, and the ball bearings at the ends of the rollers, having no other duty to perform, except to keep the rollers separated; there was a remarkably small frictional resistance.

Mr. Warner stated at a meeting of the American Society of Mechanical Engineers, that this bearing supported a weight of 4½ tons, and could be moved by the pressure of a single finger applied to the end of the telescope tubes; the actual force required to move it being four pounds.

The Simonds Rolling Machine Co. have found by experience that a bearing of the form shown at Fig. 3 gives the most satisfactory results, and that it is essential to have the surfaces upon which the balls roll hard—either of hardened steel or chilled iron.

It will be noticed that in this form of bearing no grooves are formed in the shaft, but it is left plain, and that a plain straight bush of hardened steel is put in, between which and the shaft the balls are placed; the series of balls being separated from each other by plain thin rings or washers of steel, which are not attached either to the shaft or to the bushing, but are entirely loose.

Bearings with grooves are sometimes made, however, and a common form of groove has sides at an angle of 45° with the axis.

Such grooves are employed mainly in thrust bearings, and I think there is a cause of sliding friction here, which has, so far as I know, been generally overlooked. To explain this, suppose the circles a and b, Fig. 4, to represent the lines at which the balls of a thrust bearing come into contact with the sides of the groove. In this case, the circle b is twice the diameter of a, and would therefore travel at double the lineal velocity, and consequently tend to rotate the balls at double the angular velocity that would be given by the side of the groove a, since these lines of contact occur at points on the ball which are at equal distances from its axis of rotation.

As these points of the ball must rotate at the same speed, if at all, it would appear to be plain that slipping will occur.

The proportion of the size of the ball to its distance from the center has been chosen solely for convenience in this case; but if there would be sliding friction in such a case, there must be some in every case, no matter what this proportion may be.

By changing the angles of the sides of the grooves, however, it seems that this cause of friction can be removed, by causing that side of the groove having the greatest lineal velocity to come into contact with a portion of the ball having a proportionately greater lineal velocity.

A graphic method of obtaining the angles for the sides of the grooves, to produce this result, is shown at Fig. 5, in which the line $A\ C$ represents the center line of the shaft, and $A\ B$ the plane in which the axes of the balls lie. The lines $C\ D$ and $C\ E$ pass through the ball at equal distances from its center, and the sides of the grooves should be tangent to the ball at the points $a\ b\ c\ d$ where the lines $C\ D$ and $C\ E$ intersect the ball. The proportion between the length of the lines $C\ e$ and $a\ c$, is the same as that between $C\ f$ and $b\ d$, and we have the same conditions, so far as relative velocities are concerned, as if we had a conical roller $a\ b\ c\ d$, rolling between surfaces represented by the lines $C\ D$ and $C\ E$, and it is obvious that there would be no sliding friction.

Fig. 6 is a section of a thrust bearing having grooves laid off in this way. No two grooves would be alike in such a bearing, and it would, of course, be considerably

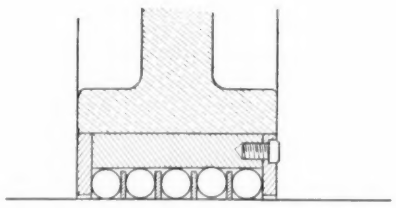


Fig. 3.

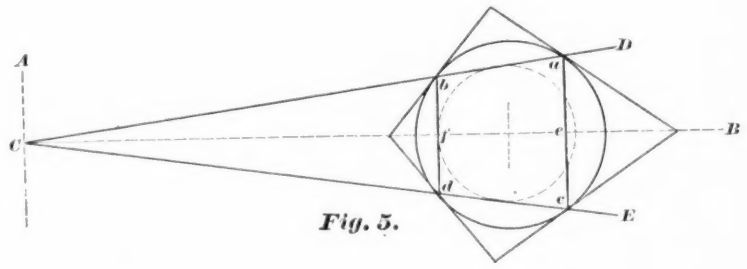


Fig. 5.

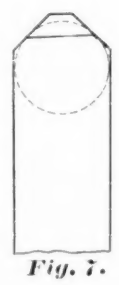


Fig. 7.

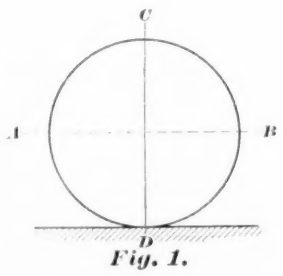


Fig. 1.

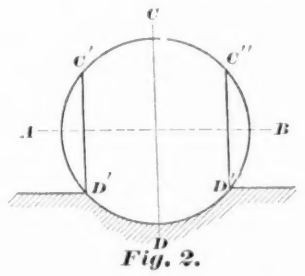


Fig. 2.

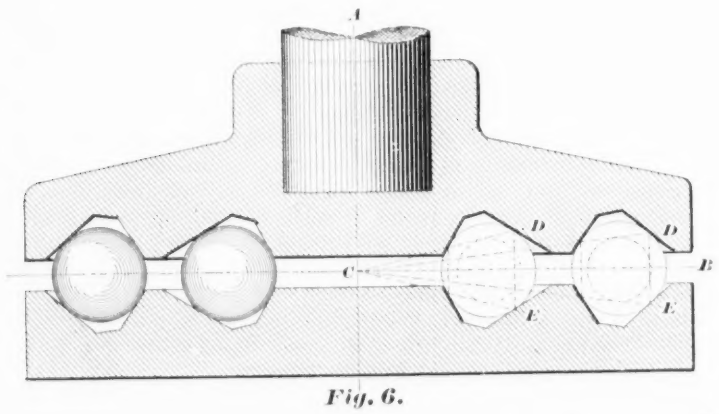


Fig. 6.

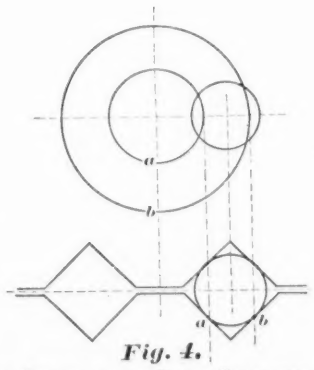


Fig. 4.

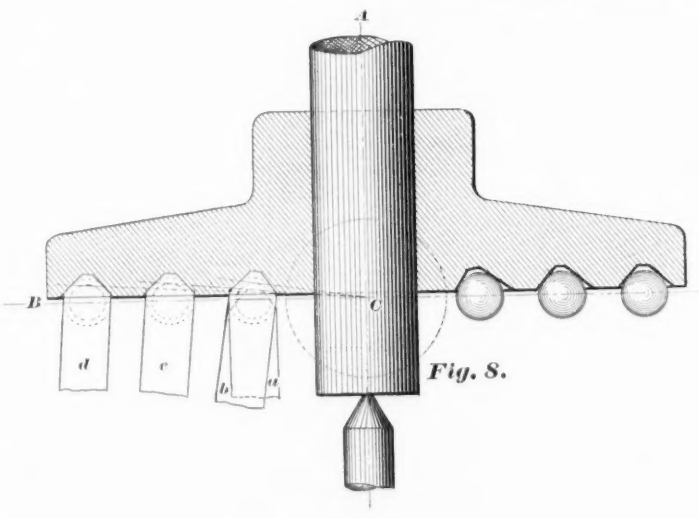


Fig. 8.

The Friction of Ball Bearings.

more trouble to make than if made in the ordinary way, but where the minimum of friction and wear is sought by the use of balls in thrust bearings, it would probably pay.

The included angle between tbe two sides of the same groove (Fig. 6), is the same for all the grooves, or, in other words, the grooves are all of the same shape, and can be cut with the same tool, the only difference between them being that the inclination of the sides of the grooves to the line passing through the axes differs in the different grooves.

This uniformity of shape of the grooves is secured by making the lines which radiate from the center (*C D*, *C E*, Fig. 5) tangent to a circle of the same diameter for each groove, as shown at Fig. 6.

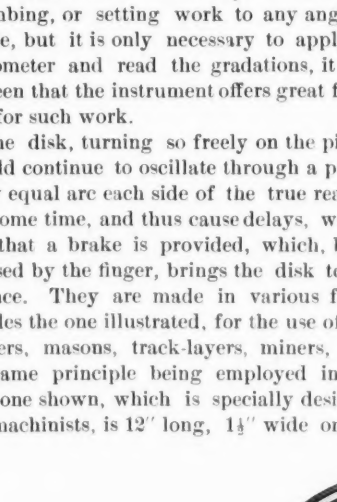
By the use of the compound rest, or any of the attachments frequently found in machine shops, by which the lathe tool can be given a circular motion, as in turning balls, the grooves in a thrust collar can be easily made of the proper shape to secure the condition shown by Fig. 6.

The center about which the tool swings should be brought to coincide with the point *C* (Fig. 6), and kept there until all the grooves are finished, the tool being moved from one groove to another by means of the upper slide of the rest. Supposing Fig. 7 to be a plan view of the tool which is to be used for finishing the grooves. Draw a line across the top of the tool from side to side, as shown. Make this line intersect the sides or cutting edges of the tool, just where it is desired to have the balls come in contact with the sides of the grooves. Then set the tool so this line will lie in the line *C B*, Fig. 6, which passes through the axes of the balls, and feed the tool in by swinging it upon the compound rest instead of feeding it straight in. By this means the line drawn upon the top of the tool will always lie in a line radiating from center *C*, and the sides of the grooves will, of course, be tangent to, and in contact with the balls at the points where the line intersects the sides of the tool. Fig. 8 shows a section of a plate attached to a shaft, and supposed to be in the lathe to have the grooves cut. The center about which the tool is swung is brought under the point *C*, and the tool adjusted to the position *a*, with the line drawn across its top coinciding with the line *C B* passing through the axes of the balls. It is then swung around, and at time of finishing the first or inner groove is in position *b*. Without moving the center of compound rest, the tool is then moved outward and swung into positions *c* and *d*. Grooves finished in this way will, it seems to me, produce no sliding friction upon the balls whatever, except that caused by the yielding of the metal due to pressure upon the bearing, and by properly proportioning things this can of course be reduced to so small an amount as to be scarcely appreciable.

The Melick Clinometer.

The accompanying illustration is of a new tool for machinists' use, called the Melick clinometer, and designed as a substitute for the spirit level, over which it seems to have some points of superiority.

The frame is constructed in much the same manner as the frame of the regular machinists' level, but has but one straight edge, for the reason that, unlike the level, it can be used with equal facility either side up, the reading being the same for the same inclination of surface, whether the instrument is applied to the upper side, or turned over and applied to the under side of a surface. The graduated dial and pointers are covered by a glass plate, the dial being nickel-plated and forming part of a wheel or disk, which turns very freely upon conical pivots, one of which is supported by the bar which passes diagonally across the face, and the other by a screw which is tapped into the frame at the back, and can be adjusted. Fixed to the diagonal bar already spoken of are the four pointers, which are made bright red to facilitate reading. They do not turn, but are fixed in the position shown, and 90° apart. One side of the disk to which the dial is attached is loaded in such a way that, turning freely upon the pivots, it always assumes the position shown in the cut when the instrument is placed upon a level surface, *i. e.*, with the upper and lower pointers indicating zero,

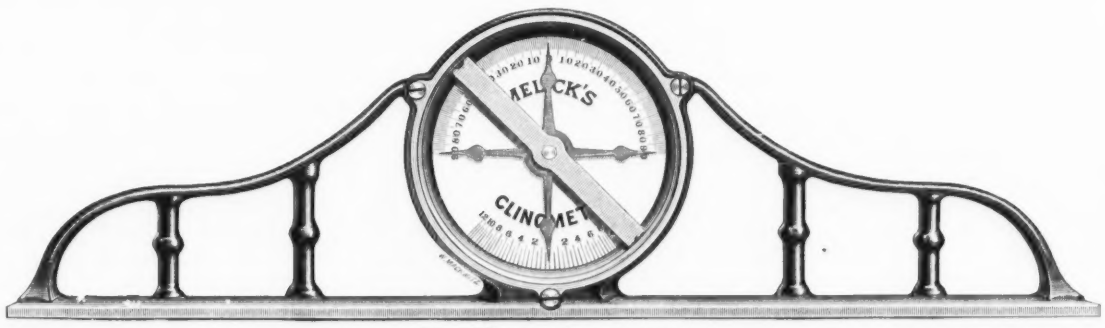


New Lathe Dog.

and the side pointers 90°. If either end be elevated the dial turns upon the pivots, the upper pointer indicating the degrees of elevation from a horizontal, and the side pointer nearest the highest end of the instrument indicating at the same time the degrees of inclination from the vertical, or the complement of the other angle. At the same time the other side pointer comes over a blank space, or the grading scale, so that confusion and mistakes in reading are avoided. When applied to a vertical surface, as a plumb rule, the reading is the same.

At the lower part of the dial is a grading scale, by which inclinations or grades can be set from ⅛″ to 12″ to the foot when desired, instead of by degrees of arc. As no adjustment whatever is necessary in leveling, plumbing, or setting work to any angle or grade, but it is only necessary to apply the clinometer and read the gradations, it will be seen that the instrument offers great facilities for such work.

The disk, turning so freely on the pivots, would continue to oscillate through a practically equal arc each side of the true reading for some time, and thus cause delays, were it not that a brake is provided, which, being pressed by the finger, brings the disk to rest at once. They are made in various forms besides the one illustrated, for the use of carpenters, masons, track-layers, miners, etc., the same principle being employed in all. The one shown, which is specially designed for machinists, is 12″ long, 1½″ wide on the face (which is ground true and straight), and weighs something less than two pounds. A sample tool which we have been afforded an opportunity for testing proves to be well made, and possesses quite sufficient accuracy and sensitiveness for the purposes for which it is designed. The makers are the Melick Clinometer Co., 718 St. Charles street, St. Louis, Mo.



The Melick Clinometer.

A budding statesman of Ohio has introduced in the legislature of that State a bill, which he claims is for the protection of building and loan associations. The most prominent feature of the bill is the levying of a tax upon the associations.

The Luckless Great Eastern.

We have so often been called upon in past years to announce the last, and the very last, and positively the very last of this magnificent but generally useless ship, which has lingered on through an obscure but profitless existence since her first voyages to New York proved a commercial failure, that the stranded hull on the Mersey shore, to be broken up for a few thousand pounds worth of old iron, may seem but a reminiscence of the fate repeatedly declared to be imminent and commonly believed to be past.

It is thirty years since she first put to sea from the Thames, and her passage down the Channel was marred by a shocking disaster, the blow-up of her steam apparatus, which cost ten lives; but the laborious efforts to launch this enormous leviathan, as she was at first called, in 1857, from Mr. Scott Russell's building yard at Millwall, had been ominous of ill success. Men were killed by the breaking of a gear attached to hydraulic engines that slowly pushed her broadside on into the comparatively narrow river, and Mr. Brunel, the eminent engineer, dying a few days afterward, was thought to be a victim of sore anxiety and severe disappointment.

One serviceable and honorable performance, the laying of an Atlantic telegraph cable, in 1866, is set down to the credit of the Great Eastern, but experience has shown that vessels of moderate size can do such work just as well. It is a sad chapter in the history of marine architecture, and some people must have lost, at one time or another, nearly $5,000,000 altogether by this immense mistake. The Great Eastern might perhaps have been converted into a very commodious floating hotel, moored in some tranquil bay; she could never have been a good sea-going ship, or competed in speed, comfort or safety, with the admirable liners of recent construction. Her engines, indeed, were manifestly of insufficien power, and she rolled grievously for want of a keel.—*The London Graphic.*

A New Lathe Dog.

We give with this an illustration of a lathe dog, which, having been intended orginally for use in the shops of the maker, was found to possess advantages which led to its being placed on the market.

The engraving gives a good idea of its construction. No wrench is required to tighten it upon the work, it being necessary only to turn the thumb-screws down until they have a bearing on the tail-piece, which is of forged steel, has a serrated edge (hardened), which comes in contact with the work, and passes through the slots shown. The width of the slots is somewhat less than the diameter of the screws, so that they are supported to their points by the threads at the sides. Both screws are pointed, and one of them enters one of several countersunk seats provided for it on the upper edge of the tail-piece. The strain on the dog when driving tends to force the tail-piece through the slot; but, owing to the pointed set-screw in its countersunk seat, this strain serves to force the tail-piece harder onto the work, and tighten the dog. The angles of the seat upon which the work rests also serve to make twisting strain tighten the dog. The object of having several countersunk seats for the point of the set-screws is to permit the tail-piece to project any desired length for different sized face plates. The main part of the dog is a steel casting. It can be removed from or placed over work without taking it from the lathe, does not deface work, as set-screws do, and does not slip when lathe is run backwards.

They are made in four sizes, taking work from ¼″ to 4″—a range which requires about twelve ordinary dogs—by Frank L. Osgood, Bangor, Me.

The Modern Steam Plant and its Management.

By Peter H. Bullock.

PISTONS AND THE CARE OF THEM.

There are two methods of making a steam-tight joint between two pieces of metal—one by grinding or scraping their surfaces until they are in perfect contact, and the other by interposing some yielding substance to fill all the irregularities between them. If these joints are to remain at rest, as, for instance, cylinder heads that are frequently ground, and flange pipe joints that are usually packed, the problem is quite an easy one; but if the joint is a movable one, there will be other conditions introduced that will not be so easily got along with.

The piston of a steam engine is a movable joint, and, to be economical, it must be practically tight at all parts of the stroke, and still move easily over quite an extended surface that is not either entirely smooth, nor always a true circle. It is necessary, therefore, to provide a yielding motion to the packing and for its lubrication; the latter under conditions of temperature quite un favorable.

A good many years ago pistons were provided with glands and follower, and had to be packed with hemp, nearly, if not quite as often as the rod or valve stem. Engineers in those days became very well acquainted with the internal arrangements of their engines, and the economy with which they ran depended more on their skill than do engines of to-day. The leakage, if poorly packed, and the friction, if packed too tight, was an unknown quantity, and depended very largely on the judgment of the person who used the wrench on the gland bolts. I remember, when a lad, of witnessing the unsuccessful attempts to start the engine in a saw-mill that had been packed by the man that run the saws, and who had used the same wrench and strength on the packing bolts as he was in the habit of using when fastening the saws to their arbors, and the piston was as firmly set as it is necessary the latter should be.

If a cylinder could be made absolutely perfect, both as to size and smoothness of surface, it is plain that a solid piston, that was also smooth and true, would fit it and be tight at any part of its length, so long as the temperature of the two parts was kept the same as when fitted together. Such perfection, however, is not to be found as expected, and were they made so perfect, the unequal expansion would quickly destroy them. To provide for the uneven surface both from make and expansion, adjustable piston packing becomes necessary. There is probably no part of the steam engine except the valve motion that has received more thought and study than pistons. There are two general classes of pistons—one where the packing rings are set out against the cylinder by springs, and the other by steam admitted under them through suitable openings provided therefor. The advantages of the latter are that the pressure of the packing against the cylinder will be in proportion to the pressure of the steam at different parts of the stroke. That is, when there is the most pressure to make it leak, there will

also be the most pressure to prevent it. This also makes the pressure variable at different parts of the stroke, and consequently the wear will be the same.

It is universally the case that, where steam packing is used, the cylinders will be worn largest at the ends. There is also usually a very disagreeable rattling in the cylinder when the steam is shut off for stopping. The only place where the writer has ever used them, and been satisfied, was in a small direct-acting steam pump, where the pressure remained practically constant during the whole stroke. In a geared engine directly connected to an elevator drum, steam-packed pistons came near causing several accidents from the fact that, when the car was descending with a load, the steam would be entirely shut off by the governor, and, there being no pressure to hold the packing tight, allowed the pistons to move very freely, and nearly regardless of compression by the valve motion; and on one occasion, with a heavy load of passengers, the engine raced to a dangerous point. When fitted with tight spring-packed pistons, there was no further trouble.

In small engines the piston head may be solid, quite closely fitted to the cylinder, and have the rings sprung into one or more grooves, as the case may be. A plain cast-iron ring cut open, and the ends made tight by a tongue and mortise joint, and thrown out by one or more springs, is a very common packing for such pistons. These make a very good piston, but there is no chance for adjustments, and, when the rings get worn loose in the grooves, steam will leak by, and the only remedy is to turn the grooves true in a lathe, and fit new rings to them.

Larger pistons, however, usually consist of four parts—the piston head, or "spider," the "bull ring," the follower and the packing, which is generally fitted either into the ring, or else each side of it between the flange part of the head and the follower. The spider and the follower should be made smaller than the cylinder, while the ring should be quite closely fitted, so it may have a bearing on nearly the whole of the lower half of the cylinder instead of the smaller bearing, as shown in Fig. 11, which is the case when the ring is too small.

The piston head will have its outward part made smaller, so that the bull ring will slide over it and bring the adjusting studs central with the ring. And now a word right here about those studs: they are there for the purpose of centering the piston, and for no other purpose. The work they have to do is comparatively light, and they positively should not be set up hard and tight; for, if they are, it will spring the ring out of truth, and, perhaps, make it bind in the cylinder, opposite some one or all of the studs. Also remember that these studs will hold the piston just where you put it, be that too high, too low, or too far either side. When the piston is not properly set it imparts its untruth to the rod, which shows the effect by a movement of the gland as the rod passes through it, and, if the error is large, by a cutting of the rod on the side the piston is too near, and by a leakage of little puffs of steam at the commencement of each inward stroke. Such leakage of steam may, however, occur from some other cause, but when seen in connection with a movement of the gland it is a pretty sure indication that the piston is not correctly centered.

HOW TO CENTER A PISTON.

We will suppose that the cylinder head is off, the follower removed, and the studs loosened up. In the first place let us find the center of the piston. We will not accept the lathe center hole and use a pair of long-legged springy dividers from it to the sides of the cylinder, but fill that hole with lead, and then ascertain the correct center, and mark it with a fine-pointed prick punch. The engine must be on the inside center, which will bring the end of the piston over the counterbore.

It is very uncertain to use any part of the cylinder surface of an engine that has been run for measuring, for centering a piston, but the counterbore, getting no wear, always remains true. Now let us chalk-mark four points in the counterbore, at the top, bottom and sides, and do all our measuring from those points, and from nowhere else. Next get the diameter between two opposite marks by fitting into it a strip of board about 1″ square, and pointed at the ends to ¼″; then mark the center of the strip, when found, with a sharp-pointed knife. For a gauge you can drive a stout needle through the end of a stick, and cut the other end to just half the whole diameter; but it is far better to make and keep a tool as shown in Fig. 12. It is simply a piece of ¼-inch brass pipe with a steel point screwed into one end of it and a sliding steel gauge in the other end, and held in any desired position by the thumb-screw. If the pipe is made about 7″ long, and the sliding gauge a little longer, it can be used in cylinders from 16″ to 28″ diameter, and, if a longer range is needed, the short steel point can be replaced by one long enough for the case in hand. We will now lay a steel square on a bench, and place the strip on which we marked the center inside and against the longest arm, then put the gauge by the side of the stick, set the point exactly to the knife mark, and tighten up the thumb-screw. Having now got a correct gauge, we will place the lower end on the bottom chalk mark and bring the point against the piston, and see how much it has got to be raised to bring the prick punch mark into line with our gauge point. If there are three studs, the top one should

Fig. 12

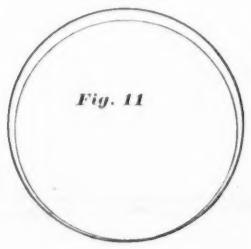


Fig. 11

be vertical, as this will bring the other two into a position to carry the load evenly between them. If there are four studs they should be placed in the same relative position—thus: X—so that two of them will carry the load, as before.

When, by adjustment of the studs, the piston has been brought to the center of the cylinder, the lock nuts should be set up solid, so as to hold the studs and piston firmly in place. The above refers to horizontal engines, and to do the work properly requires skill, experience and common sense. We must now put on the follower, and that will require strength, ornamented with judgment. A loose follower bolt is a dangerous thing; for a broken one add 25 per cent., and keep out of range of the cylinder head. The former results from a lack of judgment, as exhibited in not screwing the bolt up hard enough, the latter from a similar cause, as made manifest in screwing it too hard. If it gets loose and gently taps the cylinder head before making a more forcible demand, the man with the effeminate muscle and untrained brain, who did the job, will say that it was a "poor fit," and give a lot of other excuses with a chestnutty flavor. If the bolt gives way under the increased strain of expansion and the shock of work, and gives a new illustration of the law that two solid bodies cannot occupy the same space at the same time, the man with the assinine biceps and No. 6 hat, who was responsible for the original fracture, will claim that it was "poor iron," a "cold shut," or give some other occult and obscure reason for its failure, instead of his own brute strength and lack of judgment. I do not believe that there is a builder of steam engines in the United States who would knowingly put a poor or badly fitted follower bolt into an engine, and furthermore a bolt with a dangerous flaw in it would give way if screwed up as hard as all such bolts should be. The proper amount of force to apply to bolts and nuts under various conditions cannot be described by tongue or pen, but practice, experience, and intelligent observation of all the different conditions, will give a man a sense of touch that will enable him to put a follower bolt up so tight it will stay there, but not so hard as to break it. We may find 1¼″ follower bolts cut 8, 10, 12 and 16 threads to the inch. You can see that a certain force applied to the eight-thread bolt would put but half the strain on it as would be put onto one cut sixteen threads, were the same force applied to the wrench as in the first case.

Not long since I saw something published about special features being sometimes introduced into machines, especially to prevent interference with them. In the same desire to keep thoughtless people out of trouble, a certain builder of engines used to furnish a socket wrench and handle for the follower bolts, and near the box part of the wrench the size was reduced so that it would be weaker than the bolt it was intended for. This automatic bolt protector worked all right in one case, as it saved a bolt, but lost its own usefulness at the same time. As the saving principle was not introduced into the one made by the village blacksmith, it proved superior to the bolts, which magnanimously gave way, and incidentally furnished an opportunity for the writer to take a suburban trip of some sixty miles, for the purpose of attending a Sunday matinee with a hand ratchet accompaniment.

LETTERS FROM PRACTICAL MEN.

Vertical Belts.

Editor American Machinist:

I have been much interested in your recently published article on "Vertical Belts." It is a subject in which every machinist and engineer must feel an interest, and most of them will, I imagine, thank Messrs. Jones & Laughlins, and Wm. Sellers & Co., for their efforts to elucidate the matter.

I think most every one will agree with your deduction, *i. e.*, that more width should be given for a vertical belt than for a horizontal one, other conditions being the same, and it seems to me that Mr. Briggs' letter, taken by itself, clearly shows that increased width is indicated, notwithstanding his declaration at the outset, that a vertical belt should transmit precisely as much power as any other.

It is true perhaps, that, from purely theoretical considerations, this *should* be the case; but Mr. Briggs' letter plainly shows that his experience has shown him that, whatever *should* be the case, the *facts* are that a vertical belt is much more liable to give trouble than a horizontal one; for he says they require tighteners, and emphasizes the fact that they should be avoided wherever possible. Mr. Briggs is a practical engineer, and, of course, knows that cases arise, occasionally, in which a vertical belt is the only practicable means of transmitting power.

Now, knowing that this vertical belt is more liable to give trouble, than the same belt would give, working horizontally, the obvious thing to do, it seems to me, is to give it greater width, so that for the total tension necessary to do the given work, there will be less strain per square inch of section, and consequently less stretching and trouble.

Wm. Sellers & Co.'s allowance of 10 per cent. increased width for a vertical belt is probably about correct for most cases, they themselves not claiming that it is an exact fixed thing, nor a rule of universal application.

They state, however, that they give this increased allowance "only for the purpose of reducing the cost of maintenance," which, it seems to me, is the precise reason that any belt is given a surplus of width over what is required to enable it to barely perform its work.

All belts should, of course, have this surplus, and it is the universal practice to so proportion them.

This is not done to enable more work to be done, but simply to reduce the cost of maintenance. If it were cheaper, all things considered, to put a new belt in place every month, just barely capable of doing the work for that length of time, it would, of course, be done.

I do not write this from a mere desire to quibble, but it seems to me that there is an indication of a tendency to be influenced by the mere theoretical consideration that equal tensions should produce the same effect at equal speeds, and not to give sufficient weight to the fact that it is more difficult to maintain a given tension in one case than in the other, and that, as a consequence, more width should be given from purely practical or economic reasons. T. A. Pandie.

A Combination.

Editor American Machinist:

Referring to the grindstone *vs.* emery wheel controversy, it seems the disposition of the average man is to look at one side only, and condemn without consideration.

Narrowing the question to machine shop practice, one can name numbers of able men who advocate the total abolition of grindstones for tool sharpening; they are either manufacturers of emery wheels or their converts.

On the other hand, an army will endorse the views of "A Mechanic."

Let us grant that both grindstones and emery wheels are good when used to best advantage, and then learn to so use them, rather than curse one and glorify the other.

My own experience has not impressed me favorably with large, wet emery wheels for sharpening tools (by tools I mean lathe and planer tools, chisels, drills, etc.).

My present ideal outfit for that purpose is, a good grindstone 48 inches diameter, 3½″ or 4″ thick, running not less than 1,600 feet per minute; and, in connection with this, an emery wheel machine carrying a 1″x9″ wheel on each end of spindle, and running about 2,200 revolutions per minute, one wheel provided with water hood and tanks for wet grinding, the other with removable rests for dry grinding.

Set the grindstone and the emery wheels near each other.

Keep them in first-class order—detail a man to do it, if necessary.

Teach your men not to put 500 pounds pressure to the square inch on the surface they are grinding, and see if nine out of ten machinists do not like the combination better than either a grindstone or an emery wheel alone. "Conservative."

Pumping Water Forty Feet High.

Editor American Machinist:

Referring to an article in your issue of March 20th, headed, "A Pump Problem," the claim made by the engineer of the woolen mill, namely, of raising water a distance of not less than 40 feet, has drawn to it my attention.

When we consider that atmospheric pressure, 14.7 pounds, will only balance a column of water 33.95 feet high when supported by a perfect vacuum, it is hardly possible that when friction caused by the flow of the water through the pipes, valves, etc., the head required to give the velocity and an imperfect vacuum are taken into consideration, that anything like the result mentioned can be realized.

For the theory advanced, of *plugs* of air or gas given up by the highly charged water existing between corresponding plugs of water free from air, to hold good, the pipe would have to be very small indeed to prevent the air being drawn up through the water and along the sides of the pipe, and leaving the water behind.

That oil can be pumped to a greater height than water is quite clear, on account of the greater molecular attraction, and also the difference between their respective specific gravities.

I am anxiously awaiting the result of the investigation of Mr. Booth, and shall read any explanation he has to offer with much pleasure. WM. R. SATTLER.

A Pump Problem.

Editor American Machinist:

Reading the article by W. H. Booth, entitled, "A Pump Problem," in your issue of March 20, calls to mind some experiments made by Prof. Pohlé, of Georgetown, Col., at shaft 26 of the new Croton aqueduct. Compressed air was let into a 1½″ stand-pipe at a point 15′ from the water in the pump at the bottom of shaft. At the same time water under air pressure was forced up the pipe, and delivered at a height of 200′ or more, the air pressure at the foot of the column being about 40 pounds.

Prof. Pohlé has taken out several patents for this method of raising water from mines, and I believe has his apparatus in successful operation in many places in the West. The matter is not at all difficult to understand, as the water, being mixed with air, becomes proportionally lighter. As to the economy of this method of raising water, my own opinion is that it has not been sufficiently tested to show whether results of greater value are obtained than by other means. I do not doubt for a moment that it is possible to draw water to a greater height than 34′ by suction, as Mr. Booth suggests, and his explanation of the cause is sufficiently clear.

T. R. ALMOND.

Locomotive Cylinder Port Milling Machine.

This machine was designed especially to mill the ports of locomotive cylinders. It is made compact, has all the movements requisite, ample power to do the work, and can be readily attached to any standard locomotive cylinder. The frame or bed is fastened to the steam chest seat of the cylinder, using the bolt holes for that purpose.

The uprights are moved on the frame by means of racks and pinions, until the milling cutter is over the ports as desired, and are then securely fastened to the frame. A graduated scale let into the side of the frame facilitates accurate measurements. The crosshead carrying the spindle saddle is lowered similar to that of a planer, until the milling cutter is at the required depth, and then securely fastened to the uprights.

The spindle is of steel, of large diameter, and runs in conical bronze bearings with adjustment to compensate for wear; it is driven by a cone having four sections for a round belt or rope through gearing, the cone making eight turns to one turn of spindle.

The feed is 20 inches, automatic in either direction, is driven by a cone having five sections, and can be stopped automatically as required.

Altogether this machine appears to be well adapted to the purpose for which it is made. The manufacturers are Beaman & Smith, Providence, R. I.

A Common Error in Power Estimation.

BY W. H. BOOTH.

When an engine is driving certain machinery of the rougher description, which does not call for specially exact speed, it is frequently found without a governor.

With such an engine the speed may vary five to ten per cent. without any evil results, and, when indicating an engine so liable to vary, it is quite difficult to obtain a series of figures all taken at one speed. One is fortunate, indeed, in obtaining diagrams, and knowing the speed at the time of taking; and to do this is not easy, for the number of revolutions must be taken in a period not exceeding fifteen seconds.

It is not always that one can have the use of some instrument from which the speed of the engine can be read off exactly when the pencil is applied to the paper, and much practical indicating has to be made under conditions of small accessories. Such being the case, and a series of diagrams being obtained at various numbers of revolutions, from 70 to 80 or 80 to 90 per minute, with varying quantities of work to be done, the question then arises as to reducing all diagrams to one standard datum.

For example, suppose the work done by the engine is the pumping of water to various elevations. It is desired to find factors of efficiency at each elevation. All that the indicator tells us is the mean pressure in the cylinder, and when we have calculated the mean pressures and multiplied by all the proper factors of area—piston speed per revolution, etc.—we have for each diagram a number, which, multiplied by the revolutions per minute, give the power. But now the question arises as to equalizing all diagrams at one speed. Suppose in one diagram we find that the power is equal to 8 I. H. P. per 10 revolutions, and the engine was making 70 revolutions when the figure was taken; then we know the power to be at the rate of 56 horse-power. Another figure shows the same horse-power on the basis of 10 revolutions, but was taken when the engine was running at 80 revolutions. Its rate of work would be 64 horse-power. The power of the first diagram would also be 64 if worked out on the same basis of 80 revolutions, and this is the method often adopted for bringing all diagrams to a common basis; but it is essentially wrong, for, in the first case the same mean pressure throughout the stroke as was found in the second case was only able to drive the engine at 70 revolutions, though in the second case it drove it at 80 revolutions. An engine continues to increase its speed until its forward energy is balanced by the resistances. Put a mean pressure of 15 pounds upon a certain engine driving 40 machines. The engine starts to turn, and with every revolution runs quicker and quicker, but finally ceases to run any faster. Its power at 100 revolutions is double what it was at 50, and it would drive double the number of machines at the higher speed that it would at the lower speed, if the 80 machines driven at the higher speed (of the engine) only ran as fast as the 40 driven by the lower speed (of engine), by suitable variation in their gearing.

Take, however, the engine at 50 revolutions driving the same 40 machines as before, and increase its speed to 100 revolutions, and it will be found that at 100 revolutions it cannot now drive even 40 machines at double the speed they have been running. This proves that 40 machines at 20 revolutions per minute must take more power than 80 machines at 10 revolutions, though the total revolutions are the same. Were this not the case there would be no limit to the speed of any engine; but, as things are, resistances increase at a higher rate than the increase of power due to increased engine revolutions. When, therefore we find an engine with a mean pressure of 15 pounds running at one time at 70, and at another at 80 revolutions, then we ought to know that the resistance at 70 is greater than the resistance of the machines driven at 80 would be if only driven 70. Hence, in reducing diagrams to a common datum, the figures which are supposed raised in speed above that at which they are taken must not be calculated by the simple arithmetical proportion of speed, but to a higher ratio.

Given, for example a diagram taken at 70 revolutions from an engine driving a centrifugal pump, and showing 100 horse-power, what will be the power of the engine when driving the same pump at 80 revolutions under the same conditions? Will it be

$$100 \times \frac{80}{70} = 114.28 \text{ I. H. P.?}$$

No; for, if it would be so, why did not the engine run at 80 revolutions just as well as at 10?

Its probable power if run up to 80 revolutions would be

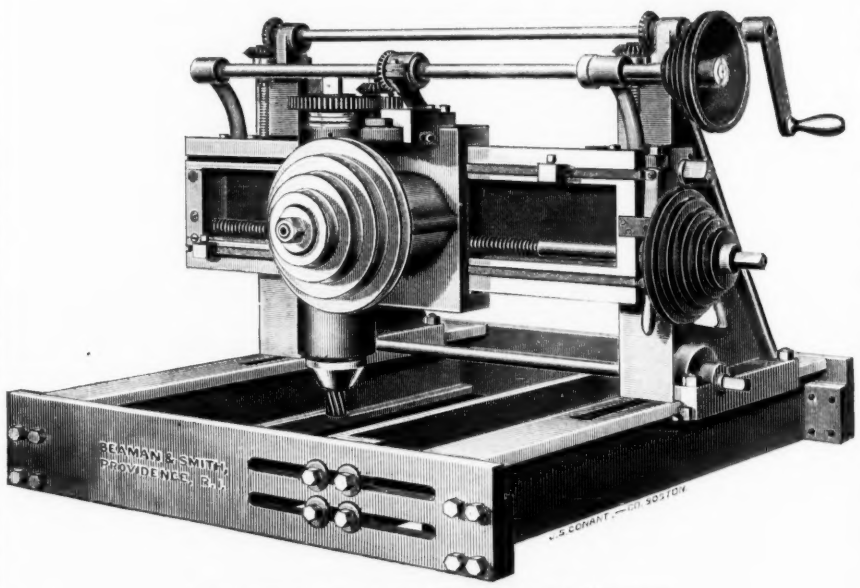
$$100 \times \frac{80^3}{70^3} = \frac{6,400}{4,900} = 130.6,$$

and the mean pressure on the piston would require to be, not, say, 20 pounds, as before, but

$$20 \times \frac{130.6}{100} \times \frac{7}{8} = 22.85 \text{ pounds,}$$

or simply $20 \times \frac{8}{7}$.

The increased mean pressure would correspound to the increase in revolutions, and the net result of more pressure at more revolutions would give a larger power to the ratio of the square of the revolutions. This, or about it, would seem to be about the correct ratio on which to equalize diagrams.



LOCOMOTIVE CYLINDER PORT MILLING MACHINE.

For any other speed datum than that at which the diagram was taken first, increase or decrease the mean pressure as measured on the card by the simple ratio of the new to old revolutions, and figure out the power on the increased card at the higher speed.

Take an actual case. A week ago I tested a large centrifugul pump delivering water at various elevations from 0 to 20 feet, through a long pipe.

At an elevation of 3 feet the power at 85 revolutions of the engine was 106.83 I. H. P. At 6 feet elevation of discharge, all other conditions being the same, the power at 80 revolutions was 107.85. Increasing this in the ratio $\frac{85}{80}$ to place it at the same level of performance, would raise the power to 114.59, or but seven horse-power more; but increasing in the ratio $\frac{85^2}{80^2}$, gives 121.75, which seems to be a more correct figure, not merely in theory, but from other reasoning from observed facts.

Whether this be exactly correct method of reducing diagrams to unit speed, I cannot say. Certain it is that the common or frequent method of rating them just in the exact speed-ratio is not correct. If to follow the rule of the $(\text{speed})^3$ ratio be not right, the truth will lie, probably, between the two, but I should incline to the belief that figuring from the $(\text{speed})^3$ is fairly correct. On this point I hope to send you some further information, as I have many diagrams taken variously at 76 and 84 revolutions for the same series of elevations, and if they appear to give an indication leading to some fixed rule, they may be of value in this question. It is, of course, best to secure as constant a speed for taking diagrams as possible, but this is difficult. In a pump the indraught of air causes racing, and was liable to occur any time.

With a tachometer, if one be so fortunate as to have a good one, each diagram can be taken by applying the pencil just as the finger is passing the datum speed, and the resistance is secured just to a nicety.

Where an engine merely varies in speed without racing, it would appear good practice to let the pencil of the indicator run upon the paper cylinder for one minute, during which the revolutions are counted with a good watch. The diagram thus obtained will be a broad, thick line, perhaps as wide as ⅛ inch, and blackest at the mid breadth of the line. A mean figure traced through the average central band of blackness would give very closely the mean power of the engine as running for one minute at the observed revolutions. Such a diagram, indeed, will be more probably accurate than any single figure taken at the speed counted during 15 seconds. Clean, sharp, single, fine line diagrams are all very well to look at, and with steady running cotton mill engines such diagrams will be taken off even when the pencil is allowed to run several times around the card, but for engines worked without a governor, or governed only through the throttle valve, and not overburdened with fly-wheel inertia, the use of the indicator requires special modification, and there seems no reason for not letting the instrument work out its own averages in the way described for a full minute of revolutions.

Our readers will remember that a few months ago a syndicate was formed under the auspices of Sir E. Watkin, M. P., Mr. Carbutt and others, for erecting a high tower in London to outrival the Eiffel Tower in Paris. Money premiums were offered for the first and second best designs, which were to be chosen by a committee of eminent engineers and architects. The time allowed has just expired, and during the next few days a large number of designs—probably more than 200—from European and American engineers, will probably be in the hands of the committee. Some very remarkable proposals will be made, and, when the wheat is separated from the chaff, some designs will be found conspicuous by their daring and invention. With a height ranging from 1,200 feet to 1,500 feet, and with ingenious methods of hoisting visitors to the top, there will be found much that will interest engineers and contractors. Most of the designs are in steel, with a weight of from 8,000 to 20,000 tons. The advantages and possible profits of such a structure are matters for the promoters, but we believe that the capital is already assured.—*London Engineer.*

It is a sad commentary on the civilization of the nineteenth century, that an effort must be made to secure the passage, in the State of New York, of a law to appoint women inspectors of factories, and to restrict the hours of labor in factories and stores to ten per day. But it is, *per contra*, a good sign when prominent speakers are willing to appear at meetings held for the purpose of influencing legislation, to advocate the cause of overworked women. The idea of a woman in a store or factory being required to work *more* than ten hours per day ought to be repugnant to every American.

This is a great country. Liberty Island, in New York harbor, contains—we believe, but we are not sure to a rod or two—thirteen acres of land. This little mite of land has been, in a reasonable view of the matter, dedicated to the Bartholdi statue of liberty. But it is wanted by the government as a place for the landing of emigrants. Comment ought to be unnecessary.

Wm. H. Weightman, consulting engineer, has removed to Para Building, 35 Warren street, New York.

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Trade Teaching.

A New York daily paper has recently been discoursing at some length upon what the able editor seems to consider to be the absurd claims put forth for schools of journalism; his opinion being evidently that journalists are the result of natural qualification, general education and training in actual journalistic work. In this opinion we are agreed; but this same paper, during the "Q" strike of locomotive engineers, declared that if the engineers were not more careful how they conducted themselves, and continued to disregard the wishes of their employers, the public would demand that schools be established for teaching men to be locomotive engineers.

This simply shows how much better a man comprehends the difficulties with which he himself has to contend, in his own occupation, than he can possibly comprehend those which others meet with in their occupations.

This editor thinks he knows of a good many points which are picked up in the actual work of a newspaper, which can only be learned by doing such work, and which, from their nature can never be taught in any school. But he evidently thinks that all there is to running a locomotive is to be taught where certain levers and valves are, and then be informed what to do with them under certain circumstances.

In his editorial work he feels the weight of the burdens pertaining to that work, and by actual experience knows the kind of training which one must have to enable him to bear them. He does not know, and in the nature of things never can know what is required to make a good locomotive engineer.

We all have a full appreciation of the difficulties which lie in our own way, and are apt to be indignant when these difficulties are made light of by others; but it is a stupid blunder to think because we cannot see or understand the difficulties others contend with, that none exist.

The Shop and the Office.

Good mechanics know very well that there is a right way and a wrong way of conducting mechanical operations, and the importance of following the proper method.

Good business men know the same thing regarding the carrying on of business operations; but trouble and disappointment often result from the fact that the one does not understand that what is true of his own business, in which he has been trained, is just as true of the other. Most of our readers—whatever else they may be besides—are mechanics, and we venture to say that most all of them can recall some instance of a trained business man undertaking to carry on manufacturing business, resulting in partial or complete failure, because he could not be made to see the importance of having the proper equipment in the shops, of having the best men in responsible positions, and allowing things to be so organized and managed by them as to secure the highest efficiency. This is a common failing of business men who undertake to carry on a manufacturing business. Mechanics can see this fault very plainly, and are often heard to express surprise and disgust at its manifestation.

But mechanics who go into business for themselves are very liable to make a similar mistake, only in a different direction so to speak. They know full well that the shop must have the latest improved tools, must be kept neat and clean, and that a perfect system must be instituted and rigorously maintained. But they forget that the very same principles apply to the office and to the methods of carrying on the business end of the enterprise. The mechanic is disgusted with the business man who, while he considers it of prime importance to have a neat, orderly and systematically conducted office, divided into different compartments for the proper and necessary separation of the various divisions of the business, and equipped with the latest improved desks, cabinet letter files, and type-writing machines, etc., thinks that the cheapest tool or machine is the proper one to buy, regardless of any other consideration, and can't see the necessity for a decent drafting-room, nor for a tool-room, nor why the boiler making and the lathe work can't just as well be done in the same room. But the mechanic who goes into business for himself, and sees to it that he has the proper tools and shop arrangements generally, while he allows the office—which, after all, is nothing more or less than a business workshop—to be shabby, dirty and disorderly, without good furniture and convenient appliances for the orderly and systematic conduct of business, makes a mistake of precisely the same nature, and one which is often attended with precisely the same results. Time spent in hunting for a letter containing quotations of prices, an order for work, or other important matter, or for a pamphlet or catalogue of importance, is just as much lost as is time spent in looking for taps, reamers or lathe dogs in the shop. A thorough system of accounts, in charge of a competent bookkeeper, is as important as a good tool-room system; and good desks and cabinet letter files in which papers can be kept clean and in order, and instantly found when wanted, are as important as good lathes, planers and drill presses, in proportion to the money required to secure them, if not more so.

System, order, and the adoption of correct methods are as important in one part of a business as in another, and those who recognize this fact are the successful manufacturers, whether trained as mechanics or business men. Those who fail to recognize it, and yet manage to get along, either do not meet with the competition of others upon even ground, or are not successful.

A bill has been introduced in Congress, the object of which seems to be to secure the services of a competent baker for each garrisoned post of the army, and some comment has been made on the fact that the rate of pay fixed by the bill for the services of the baker is more than double that of a sergeant of infantry. The pay of the baker is to be the munificent sum of $35 per month, which, in view of the fact that he has spent some time in acquiring a knowledge of his business, and is a very useful member of society, would seem little enough. If the sergeant of infantry gets less, then so much the worse for the sergeant of infantry, and he may reflect on the advantages of having a trade. This thing, of claiming that one man's pay should be kept down simply because another's is low, is all nonsense.

Once more the machinist is on top. We mentioned some time ago the fact that James G. Blaine, Jr., had started in to learn the machinist's trade, and called attention to the "slopping over" in the newspapers caused by the fact. He worked at it only a few months, however, when he was declared to have mastered all the mysteries of the art, and went firing with a view to become an expert engineer. Well, he has now been appointed to some sort of a position under the government, at a salary of $2,000 per year. If six months' apprenticeship at the machinist's trade did that much, what would three or four years have done?

On the Chicago, Milwaukee & St. Paul Railroad, March 12, two freight trains came together, wrecking the engines and many of the cars; those cars of the east-bound train not wrecked by this collision started back down the grade, and collided with another east-bound train, wrecking its engine, and completing the smash-up. The wreck, it is said, will cost about $100,000.

This amount would equip 2,000 cars with automatic brakes, which would prevent such an accident. And the third train might just as easily have been a passenger train, in which case some lives would almost inevitably have been lost.

QUESTIONS AND ANSWERS.

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly and according to common-sense methods.

Every question, to insure any attention, must invariably be accompanied by the writer's name and address. If so requested, neither name, correct initials nor location will be published.

(125) M. M. Co., Middletown, O., writes: Please let us know which is the most economical for heating a shop—to use small pipe, say 1 inch diameter, or to use larger pipe or light tubing, say 3½ inches diameter? Also, how do you calculate on the surface required to heat a room with either live or exhaust steam? *A.*—We prefer to use the small pipes. The first cost may be a little more than that of the larger ones, but with small pipes less steam for heating will be required. For finding the heating surface see answer to Question 297, in our issue of July 25, 1889.

(126) A. E. P., Ottawa, Canada, writes: I am using an engine which has a variable automatic cut-off; it has one eccentric keyed to the shaft which controls the exhaust valve; the other eccentric is controlled by a shaft governor. Can I do without one eccentric and have as good results as now by following the design of valve motion of the high-pressure cylinder in compound engine of your issue of March 6? *A.*—No; your engine is not designed for that kind of valve motion. 2. Please let me know if I can have the first volume of your paper bound. *A.*—We cannot furnish the numbers complete for the first volume.

(127) C. A. L., Richmond, Me., writes: I have seen 50,000 T. S. marked on boiler shells. I would like to know how this tensile strength has been computed. *A.*—The tensile strength marked on the boiler sheets has been obtained by experiments; strips are cut off the plate, and then tested in a machine made for the purpose. 2. Do you think a small boiler made of 14 oz. sheet copper would stand a pressure of 5 pounds per square inch, provided it is well stayed? *A.*—That will depend on the size and type of boiler. If it is a cylindrical boiler, it will depend on the diameter. On general principles we should say it will not.

(128) E. M B., Boston, Mass., asks: Which would be the strongest to use for a torpedo boat—sheet-iron $\frac{3}{16}$ or ⅛ inch thick? The boat is 52 feet long. *A.*—$\frac{3}{16}$ iron. 2. Which would be the strongest and safest way to lay the iron—lengthways or around the hull? *A.*—Lengthways. 3. Which is the best size of sheet—45x15 inches, or 36x12 inches? *A.*—You may have to use both sizes; the larger size at midship, and the smaller size at the ends. Neither size is a good one to use; they are too small. The proper way to proceed is to make a drawing of the hull, and choose such sizes of sheets which will give the least amount of labor in riveting, and have the sheets cut to order.

(129) F. S. D., Newport News, Va., writes: I have an engine with cylinder 2¼-inch bore by 3¼ inches stroke. I want to put it into a boat 18 feet long, 4 feet wide, and about 2 feet 3 inches deep. I want to have as much speed as possible, and carry three persons. I propose using a 12-inch wheel, with 21 inches pitch. What would probably be the speed of the boat with a steam pressure of 75 pounds? Can you make any suggestion to increase the speed? *A.*—The speed will depend on the lines of the boat, type and condition of engine and boiler, and other considerations. You may be able to attain a speed of six to seven miles an hour. The proportions of the propeller are good. We cannot make any suggestions from the data you have given us.

(130) J. R. B., ———, writes: Please state whether the pressure in the boiler affects the horse-power. Also give the tensile stress on a boiler 63 inches diameter, 16 feet long, carrying steam at 100 pounds. *A.*—If the pressure in the boiler is increased, and can be maintained, the horse-power of the boiler will be increased. The tensile stress can be found by the following formula:

$$s = \frac{P\,d}{2},$$

in which s represents the tensile stress for every inch of shell, P the steam pressure per square inch, and d diameter of boiler in inches. Substituting for the letters their values, we have

$$s = \frac{100 \times 63}{2} = 3{,}150 \text{ pounds},$$

which is the pressure a strip 1 inch wide of the shell has to resist. If this stress of 3,150 pounds is divided by the thickness of the shell, we obtain the tensile stress per square inch of metal.

(131) G. D. T., Hightstown, N. J., writes: I have considerable trouble with a friction wheel; it is made of wood, with leather glued around it. It runs against another wheel, and becomes so hot as to melt the glue. How can I overcome the trouble? *A.*—We should try, instead of the glue, a paste which heat will not melt. Probably the following paste may answer your purpose: To one pint best wheaten flour add resin, very finely powdered, about two large spoonfuls; of alum one spoonful in powder; mix them all well together,

put them in a pan, and add by degrees soft or rain water, carefully stirring it till it is of the consistence of thinnish cream; put in a sauce-pan over a clear fire, keeping it constantly stirred, that it may not get lumpy. When it is of a stiff consistence, so that the spoon will stand upright in it, it is done enough. Be careful to stir it well from the bottom, for it will burn if not well attended to. Empty it out in a pan and cover it till cold, to prevent a skin forming on the top, which would make it lumpy. Perhaps some of our readers can give you a better way of overcoming the trouble.

(132) R. F. N., Aurora, Ill., writes: Please give me a rule for obtaining the necessary throw of an eccentric when the width of the steam port is known. *A.*—Add to the lap the width of the steam port; the sum will be one-half of the throw, or eccentricity of the eccentric. With this throw the port will be fully opened—in some cases it is desirable not to open the port fully; in such cases the throw must, of course, be reduced. One-half of the throw should be equal to the lap plus the amount of opening. 2. Can you tell me what the effect will be on one eccentric by moving the other in a locomotive? *A.*—If both eccentrics are correctly set, then, in moving one of them a distorted valve motion will be the result. In ordinary American locomotives the evil effect will not be so much noticed when the link is in full gear and the center of the link block is directly in line with the center of the eccentric rod pin, which is actuated by the eccentric correctly set; but, as soon as the link is moved towards midgear, the incorrectly set eccentric will influence the motion of the valve, and will either destroy the lead or increase it so as to be detrimental, and the maximum of this increase or decrease will take place when the incorrectly set eccentric is in full gear, and the otner eccentric has ceased to have an influence on the motion of the valve. 3. On a locomotive the lead is $\frac{1}{16}$ of an inch at the front port, and $1\frac{1}{8}$ inch at the back port. What is the trouble? Is there any way of setting the eccentrics correctly at once? *A.*—Assuming that the valve rod is of the correct length, it will be found that either one or both the eccentric rods are too short. The first thing to do is to adjust the eccentric rods so that the lead will be equal at both ends of the cylinder, and then move the eccentrics so as to obtain the correct amount of lead at each end of cylinder. A practical example of setting the valve gear of a locomotive has been given in an article on Modern Locomotive Construction, in our issue of April 30, 1887. You may possibly place the eccentrics in the correct position at once, but generally, in the erecting shop, it will require more than one setting. If the whole valve motion is correctly laid out on paper, the eccentrics can then be set according to the drawings in their correct positions at once, but it is doubtful if any labor will be saved by this method.

(133) J. S., Newark, N. J., asks: If the boiler pressure is 80 pounds per square inch, and the engine cuts off at ¼ stroke, what would be the mean effective pressure? Also, what will be the mean effective pressure when the pressure is 65 pounds, engine cutting off at $\frac{1}{5}$ stroke? Please give me a rule so that I can compute it myself. *A.*—In the first example steam is cut off at ¼ of the stroke. To find the ratio of expansion, which is the first thing we have to do, divide the denominator by the numerator of the fraction which expresses the part of the stroke at which steam is cut off; hence we have $4 \div 1 = 4$, which is the ratio of expansion. Look for this number (4) in a table of hyperbolic logarithms; opposite to it will be found 1.386; add 1; the sum will be

$$1 + 1.386 = 2.386.$$

Multiply this product by the absolute steam pressure, which is equal to the sum of the pressure indicated by steam gauge and the atmospheric pressure, 14.7 pounds, say 15 pounds. The absolute pressure will therefore be equal to $80 + 15 = 95$ pounds. Multiplying 2.386 previously found by 95, we have $2.386 \times 95 = 226.67$ foot-pounds of work performed during the stroke. Divide this by the ratio of expansion (4):

$$\frac{226.67}{4} = 56.66 \text{ pounds mean pressure.}$$

From this we must deduct the absolute back pressure; the remainder will be the mean effective pressure. The whole matter is summed up in the following formula:

$$\frac{(1 + \text{hyp. log. } r)\ Pi}{r} = P_m.$$

In which r is the ratio of expansion, P_i the absolute initial pressure, and P_m the absolute mean pressure. Subtracting the absolute back pressure from the mean pressure, we obtain the mean effective pressure. It must also be noted that we have taken the boiler pressure for the initial pressure; the latter pressure is nearly in every case a little less than the boiler pressure, and this reduction should be taken into account. For the sake of simplicity we have neglected the clearance, which, for an exact computation, should be correctly determined and allowed for. In the second example, assuming 65 pounds to be the initial pressure, we have $65 + 15 = 80$ pounds absolute initial pressure P_i; the ratio of expansion r, is $5 \div 1 = 5$; and the hyperbolic logarithm of 5 is 1.069. Substituting for the letters in the formula their values, we have

$$\frac{(1 + 1.069) \times 80}{5} = 41.744$$

pounds mean pressure. Assuming the absolute back pressure to be 20 pounds, we have 41.744 — 20 = 21.744 pounds mean effective pressure. You will find this rule explained in our issue of March 20, current volume.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Thursday for the ensuing week's issue.

Link-Belting and Sprocket Wheels.

Send for Catalogue of Link-Belting.

Over 50,000,000 feet of Link-Belt in use.

Link-Belt Engineering Co., Philadelphia and N.Y.

Shafting Straighteners. J. H. Wells, Tampa, Fla.

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

The Improved Justice Hammer. Williams, White & Co., Moline, Ill., manufacturers.

R. Dudgeon, 24 Columbia st., New York, Improved Hydraulic Jacks and Roller Tube Expanders.

Pattern and Brand Letters. Vanderburgh, Wells & Co., cor. Fulton and Dutch sts., New York.

Davis Key-Seating machines kept in stock by Manning, Maxwell & Moore, 111 Liberty st., N. Y.

The best Upright Hammers run by belt are made by Jenkins & Lingle, Bellefonte, Pa.

Ice and Refrigerating Machines, 140 sold, and all successful. David Boyle, 521 Monroe st., Chicago, Ill.

"How to Keep Boilers Clean." A 96-page book mailed free by Jas. E. Hotchkiss, 120 Liberty st., N.Y.

Selden Packing for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N.Y.

Castings for small and medium-sized vertical engines. Humphrey's Foundry, Bellefontaine, Ohio.

Milling Machines. Pedrick & Ayer, Philadelphia, Pa.

Universal Grinding Machine. Pedrick & Ayer, Philadelphia, Pa.

Whiton's Chucks. S. A. Smith, 23 S. Canal st., Chicago, Western Representative.

Light Special Machinery and Tools to order. The Meriden Machine Tool Co., Meriden, Conn.

For the latest Improved Diamond Prospecting Drill, address the M. C. Bullock Mfg. Co., 138 Jackson st., Chicago, Ill.

Send $1 for Catalogue D, Fine Tools and Supplies. Over 550 pages. Fully illust'd. Free when $10 worth goods are ordered. Frasse & Co., 92 Park Row, N. Y.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

Split Pulleys at low prices and of same strength and appearance as Whole Pulleys. Yocum & Son's Shafting Works, Drinker st., Philadelphia, Pa.

Patent Attorney. R. G. DuBois, 715 11th st., Washington, D. C., procures first-class patents on inventions. Valuable Hand-book on patents free.

S. W. Card & Co., Mansfield, Mass., make everything in the line of Taps and Dies. S. A. Smith, 23 S. Canal st., Chicago, Western Agent.

The Sure Grip Steel Tackle Blocks must fill the bill, according to the large sales reported. See advertisement, page 13.

Watch this column for our Weekly Announcement of Bargains. Selling Overstock. McFadden Co., 1,025 Market st., Philadelphia, Pa.

Curtis Pressure Regulators. Curtis Return Trap. Curtis Damper Regulator. See March 20, p. 12. Send for circular No. 17. Curtis Reg. Co., Boston, Mass.

Patents.—Patent soliciting of high class.
D. Walter Brown, 31 Nassau st., New York.

Send for "A Brief History of Patent Legislation in the United States."

25" Upright Drills a specialty. Finely made.
28" great capacity, quickly operated, prices low.
32" Send for list of firms using our Drills. J. E.
36" Snyder, Worcester, Mass.

25" 32" 37" 42" "Only Drill Press built on 'Ko rekt' principles, even if they come from Jersey." Gould & Eberhardt, Newark, N. J.

C. H. Redman & Co., Newark, N. J., Manufacturers of Light Machinery, Automatic Selling Machines, Telephone and Telegraph Instruments, Sewing Machine Attachments, Models, etc. Contracts solicited.

The Lexington Gear Works, of Lexington, Mass., have issued a Catalogue of some six hundred sizes of Cut Iron Spur and Bevel Gear Wheels. Every machine or manufacturing concern in the country should send for a copy.

Every draftsman needs one. The Engineer's Sketch Book of mechanical movements, appliances, devices, contrivances, etc., by T. W. Barber. 1,936 illustrations. 8vo. cloth, $3. Catalogue of books on mech. subjects free. E. & F. N. Spon, 12 Cortlandt st., New York.

The Prize Designs for Pumping Stations are suggestive to those about to build a Boiler House or Electric Light Station. Six months' subscription ($2) to *The Engineering and Building Record* will secure the 17 selected designs, also the Prize Essays on Road Making and Maintenance. 277 Pearl st., New York.

De Lamater Screw Propeller Wheel made only by The Samuel L. Moore & Sons Co., Elizabethport, N. J., who have purchased from C. H. De Lamater & Co., New York, all their patterns, books of record, gauges, etc. Location and equipment well adapted for Heavy Steamship Repairs.

Stub Ends and Connecting Rods for small connections. Especially adapted for Valve Rod for Steam Engines.
T. C. Dill Machine Co.,
Philadelphia, Pa.

T. R. Almond wishes to form a company for the manufacture of his patent angular coupling, or to make arrangements, either by sale of patents outright or otherwise, whereby this valuable invention may be properly placed upon the market. Address T. R. Almond, 83 and 85 Washington st., Brooklyn, N. Y.

Just concluded. "Practical Drawing." By J. G. A. Meyer. Copies of the American Machinist containing the above series of 93 articles sent by mail to any address in the U. S., Canada or Mexico, for $4.65, or single copies 5 cents each. American Machinist Publishing Co., 96 Fulton st., New York.

H. B. Roelker, 22 Cortlandt st., New York, late Sup't De Lamater Iron Works, will hereafter manufacture the De Lamater Screw Propeller. Propellers of same pattern and workmanship as formerly made by the De Lamater Iron Works. Each designed for its special work at lowest prices. Consulting Expert and Constructing Engineer. Estimates made on machinery and on damages.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram; also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price $2, postpaid. Published by John Wiley & Sons, 53 East 10th st., New York.

"Binders" for the American Machinist. Two styles, the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. American Machinist Publishing Co., 96 Fulton st., New York.

Just concluded. "Modern Locomotive Construction." By J. G. A. Meyer. The above series of 106 articles, which have attracted so much attention everywhere, is now concluded in newspaper form. Copies of the American Machinist containing the entire set sent by mail to any address in the U. S., Canada or Mexico for $5.30, or single copies 5 cents each. American Machinist Publishing Co., 96 Fulton st., New York.

MANUFACTURES.

The Bessemer (Ala.) Tool Works have begun operations.

The Worumbo Woolen Mills, Lisbon Falls, Me., are to be enlarged.

The Sheffield Engine, Boiler and Foundry Works will be established at Sheffield, Ala.

The Bessemer (Ala.) Land and Improvement Company expect to build large car works at Bessemer.

The Western Fence and Machine Co. has been organized to operate at Henderson, Ky. Capital stock, $30,000.

The $250,000 stock for the new Indian Orchard Mills has all been taken by fifty prominent business men of Springfield.

The Truxal & Dunmeyer Machine Co. has been incorporated, to succeed Truxal & Dunmeyer, at Chattanooga, Tenn.

The Combined Locks Paper Company, Appleton, Wis., will build a large paper mill. Heretofore this company has made only pulp.

The McDonald Rolling Mills, St. Louis, Mo., will begin experimenting with gas furnaces. If successful, gas will be used altogether.

The woolen plant of Gordon Bros., Hazardville, Conn., which was recently destroyed by fire, will be replaced by a new building, which will be 100x50 feet.

The stockholders of the Turner Rapid Heater Company, of Meriden, Conn., have voted to increase the capital stock of the company from $20,000 to $100,000.

The Tanite Co., Stoudsburg, Pa., has issued a new and elegant catalogue of emery wheels and grinding machines. It is well illustrated, and printed on excellent paper.

The Hendey Machine Co., Torrington, Conn., have issued an attractive catalogue of machine tools, such as lathes, shapers, planers, drills, presses, cutting-off machines, etc.

There is a movement to organize a stock company, with a capital of $100,000, to build logging cars, at Anniston, Ala. Pratt & Schroeder, of Howell, Mich., are interested.

The capital stock of the Ranken & Fritch Foundry and Machine Co., St. Louis, Mo., has been increased to $300,000. The intention is to erect and equip one or more new buildings.

A charter has been granted the Summit (Miss.) Mills, with a capital stock of $250,000, to erect a cotton mill. The city has been authorized by the Mississippi Legislature to subscribe $20,000.

The Chicago Railway Supply Co. has been chartered in Illinois, to manufacture railroad supplies. The capital stock—$300,000—is subscribed for by M. N. Grable, E. M. Walker and T. A. Quinlan.

The Hartford Steam Boiler Inspection and Insurance Company are to furnish the plans for a boiler house, boiler and chimney, for A. S. Rogers, who will build a shoe factory at Chelsea, Mass.

Speirs & Moore have built, at Worcester, Mass., a shop, 40x70 feet, with ell 25-foot square for engine and boiler-room. They will do all kinds of drop forging in steel, iron and copper in the new shop.

Rankin & Bridgers, Atkins, S. C., expect soon to erect a saw-mill of 30,000 feet capacity, with planing mill and kilns, 20 miles above their present location. The mill at Atkins will cut boards only.

The Board of Trade of Lawrence, Mass., has appointed a committee of five to select a site, and determine the cost of erecting a large building to be let out to small industries for manufacturing purposes.

The Putnam Machine Co., Fitchburg, Mass., has just shipped to Pittsburgh, Pa., a planer 100 inches wide, weighing 70 tons. The company is also shipping tools to the Watertown Arsenal and the Washington Navy Yard.

An enlargement is to be made to the Peabody Mills at Newburyport, Mass., by a brick addition, 50x30 feet. The building, when complete, will be fitted up with improved machinery for trimming, folding and baling cotton goods.

The Briggs Manufacturing Company, Voluntown, Conn., has in contemplation the starting of a cotton mill at Albany, Ga. It is said the Briggs Company will put $150,000 into the enterprise if the citizens will put in an equal sum.

The St. Louis Steel Casting Company has one building, 75x80 feet, and have begun the erection of another, 50x80. The company will give particular attention to the making of such castings as gear wheels and steam engine and locomotive work.

Edmund Yost, machinist, brass founder and finisher, Newark, N. J., will, on or about April 1, remove to his new factory, 350 to 352 Plane street. Increase of business and a desire to better serve his customers made a removal to more commodious quarters necessary.

At Baltimore, Md., the Electrical Construction and Manufacturing Co. has been incorporated by Charles Selden, C. H. Jones, Jr., C. W. Huntington and others, for the manufacture and sale of electrical supplies, construction of electric light plants, etc. The capital stock is $35,000.—*Manufacturers' Record.*

The blue catalogue—pocket size—of the Brown & Sharpe Mfg. Co., Providence, R. I., has come to be considered a standard work, quite as popular with mechanics as with manufacturers. A new edition of this catalogue has been issued, which contains a list of new tools and other interesting matter of value to every machinist in the country.

At Charleroi, a new town near Pittsburgh, Pa., what is said to be the largest plate glass works in the world is to be established. The main building of the glass works will be about 1,200x800 feet, and will cost $750,000. It is expected to have the works in operation by October 1, this year. G. L. Crause, of Akron, Ohio, is president of the company.

Negotiations are said to have been completed for the establishment at Minneapolis, Minn., of a woodenware plant that will cost from $50,000 to $75,000, and be in operation by July. The projectors are E. F. Bousfield, of Cleveland, Ohio, and Martin McVoy, of Bay City, Mich. The main building will be 64x208 feet, and there will be a dry kiln and other buildings.

There is water-works agitation at Huntington, Ind.; Manchester, Iowa; Anville, Pa.; Kansas City, Mo.; Tilford, Dak.; Foxboro, Mass.; Salt Lake City, Utah; Franklin, Tenn.; Wheaton, Ill.; Imlay City, Mich.; Needham, Mass.; Boulder, Col.; Wilmington, Del.; Sidney, Ohio; Mansfield, Ohio; Santa Fe, N. M.; Wilksbarre, Pa.; San Bernardino, Cal.; Lyons, Col.; Trenton, Tenn.

The Enterprise Foundry Company, whose works at Allegheny, Pa., were burned in October, is rebuilding on a larger scale. The foundry floor will be 265x60 feet, and the structure will be of brick. The fitting shop will be two-story, 40x60 feet, and the whole works will be in operation some time in April. The company will make a specialty of light castings and light hardware.

The Texas Rolling Mill and Iron Works Company has been organized at Fort Worth, Tex., for the purpose of manufacturing merchant bar iron. The officers are: G. E. Beach, president and general manager; J. C. Williams, vice-president; H. Schwartz, secretary; E. H. Keller, treasurer; P. H. Durack, superintendent. It is expected to have the works in operation this spring.

At a meeting of the water-works committee of the board of public improvements, specifications for the new low-service engines to be placed at the pumping station at the chain of rocks were examined. The board will advertise for bids on the engines in a few days, and the contract will be let before April. The engines are to have a capacity of 20,000,000 gallons per day each. The estimated cost, exclusive of the foundations, is $150,000.—*Age of Steel* (St. Louis).

Consul-General Sutton, at Nuevo Loredo, Mexico, has reported to the State Department that 25,000 tons of American steel rails have been recently imported into Mexico for use in the construction of the Monterey & Mexican Gulf Railway. He says the president of the road informed him that the cost was less than it would have been on the same quantity of European rails of the same grade, and the consul congratulates this country on the transaction, as being the first successful competition in Mexico with European products.

Work will be suspended at the Katahdin Iron Works in a week or two, the kilns having been filled for the last time. No wood has been cut this year. There are various opinions as to the ore supply, but it is a fact that it costs more to get it than the prices received for the iron will warrant. Various parties have, at different times, attempted to operate these works, but none of them have ever made any considerable amount of money, and several have sunk a good deal. There is a vast amount of lumber in that section which is very valuable, and mills for the manufacture of the same will probably be built sooner or later, as the railroad communication is such that it can be advantageously marketed.—*Piscataquis* (Maine) *Observer.*

The business people of Bellevernon, Pa., are exulting over the prospect of the location of a large iron mill, and other smaller manufacturing plants, at that place. For some months past, and especially since the location of the mammoth plate-glass works at Charleroi, two miles away, representatives of Eastern capitalists have been looking about within the Bellevernon gas field for advantageous locations for manufacturing plants. S. F. Jones & Co., a banking firm, who own a large farm on the outskirts of town, offer 12 acres as a site for an iron works, which, it is said, has been accepted. The works will be quite extensive, giving employment to from 400 to 500 persons.—*Connellsville* (Pa.) *Courier.*

Machinists' Supplies and Iron.

New York, March 29, 1890.

Iron—American Pig.—No change of importance has taken place since last week, buyers still showing a disposition to hold off for lower prices. We quote standard brands No. 1 X Foundry, $18.50 to $19; No. 2, $17.50 to $18. Grey Forge, $16.50 to $17. Southern irons have sold at $17.75 to $18 for No. 1 X Foundry, and $18 to $18.25 for No. 2.

✲WANTED✲

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Wanted—Good machinists; also a few exp'd scrapers. The Pond Machine Tool Co., Plainfield, N. J.

Draftsman on heavy machinery wants work. Good references. Address "Detail," American Machinist.

Wanted—Position as foreman of machine shop in the vicinity of N.Y. Exp'd in marine, stationary engines and gen'l machinery. Hustler, Am. Mach.

Foreman boiler maker, 8 years' experience as foreman, is open for engagement. Thoroughly competent. Best of reference. R., American Machinist

Wanted—Good general machinists to work on Corliss engines, ice and refrigerating machinery. Frick Company, Waynesboro, Franklin Co., Pa.

Pattern Makers—Three first-class pattern makers wanted in a large mfg. house. None but competent men need apply. N. O. P., Am. Machinist.

Wanted—A few good machinists on marine engines, printing presses, shoe machinery, etc. Fore River Engine Co., Weymouth, Mass.

Wanted—By a gentleman of education, thoroughly understanding mach'y business, position in charge of office work, correspondence, etc. Iron, Am. Mach.

Machinists Wanted—First-class vise and machine hands of good habits can find steady employment and liberal wages. Address Morgan Engineering Company, Alliance, Ohio.

Draftsmen wanted who are accustomed to designing power machinery, especially cranes. Address, stating age, experience, references, and compensation expected, Box 1, American Machinist.

Wanted—Position as sup't in machine shop, or would work as machinist awhile with concern meaning business. Would prefer first-class concern making absorption ice machines. L. P. H., Troy Iron Works, Troy, Ala.

A member of the A. S. of M. E., with 12 years' experience in the design, construction and management of modern steam plants and general machinery, wishes to correspond with builders in need of sup't or engineer. Best references and reason for wishing to change present location. Address Engineer, care American Machinist.

✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 35 cents per line, each insertion.

Cheap 2d h'd Lathes & Drills. S. M. York, Clev'd, O.

Koopman's Scales for quick measurements.

Just out; aluminum-steel hack-saws, hard but not brittle. Crescent Mfg. Co., Cleveland, Ohio.

New catalogue of engineers' specialties free. Crescent Mfg. Co., Cleveland, O.

Light and fine machinery to order; Foot Lathe. Catalogue for stamp. E. O. Chase, Newark, N. J.

Turned and Higly Polished Iron and Steel Shafting a specialty. Merwin McKaig, Cumberland, Md.

Complete list of our Scales and other new tools for 2c. stamp. A. T. Koopman, Chicago.

Castings of every description and machinery built. Address Cedar Point Foundry, Port Henry, N. Y.

Inventions perfected; experimental work; fine tools, dies & light mach'y. C. Wadsworth, 90 Fulton st., N.Y.

For Sale—Amsler Polar Planimeter; German silver; almost new. P. O. Box 736, S. Bethlehem, Pa.

For Sale—One-half or entire $60,000 controlling interest incorporated mfg. company, with salary. Charles Frothingham, Carrier 22, Buffalo, N. Y.

Engineers wanted to send their addresses and receive free a 25 cent book, "Hints and Suggestions for Steam Users." Lord & Co., P. O. Box 1262, Phila., Pa.

Inventions or improvements in measuring instruments & other fine tools wanted to manufacture & sell on royalty. "Tools," American Machinist.

Simonsen-Walter Mfg. Co., Jefferson City, Mo., with modern foundry, machine and wood-work plant, wants spec. to manuf. for Western trade

Wanted—A first-class shaper, about 24-inch stroke, with all modern improvements. Address The Nail City Lantern Company, Wheeling, W. Va.

Wanted—To buy second-hand lathes, planers and shapers of all sizes. Must be cheap and in good order. Fosdick & Plucker, 6th and Culvert Streets, Cincinnati, O.

How to remove and prevent scale in steam boilers at a cost of ten cents a week. Send postal for circular to Pittsburgh Boiler Scale Resolvent Co., Pittsburgh, Pa.

Wanted—To buy partnership in a good machine works, by a mechanical engineer of unquestionable experience in the line of artificial ice machines and refrigerating appliances. ⅓ or ½ interest in a medium works where engines are or can be built, preferrred. Address A, American Machinist.

8,200 Copies of
20 YEARS WITH INDICATOR
sold to March 30th, 1890. Vo's. 1 and 2 in one vol., $2.50.
JOHN WILEY & SONS,
53 E. 10th Street, N. Y.

BRADLEY HAMMERS AND FORGES.
The BEST HAMMERS in the WORLD RUN BY BELT.
Over 1500 In Use.
Three Styles, 15 lb. to 500 lb. Heads.
Our FORGES heat irons fast enough to keep Hammers and men fully employed.
Send for Catalogue and Prices.
BRADLEY & COMPANY, Syracuse, N. Y.
63 Murray St., NEW YORK. 98 Sudbury St., BOSTON.

JOHN WILEY & SONS, NEW YORK,
Issue Catalogues on the following subjects with full titles and press notices.
No. 1. CIVIL ENGINEERING.
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" 3. BRIDGES, ROOFS, ETC.
" 4. HYDRAULICS, ETC.
" 5. STEAM ENGINES, BOILERS, ETC.
" 6. CHEMISTRY, ELECTRICITY ETC.
" 7. MATHEMATICS, ASTRONOMY, ETC.
" 8. ASSAYING, METALLURGY, MINERALOGY, ETC.
FREE BY MAIL ON ORDER.

DEPARTMENT OF THE INTERIOR.
Washington, March 13, 1890.

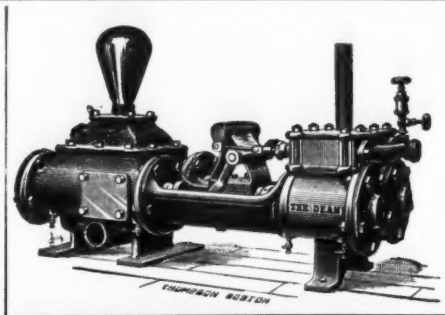
Sealed proposals for erecting an engine house and impounding reservoir, furnishing pumping engines and boilers, cast and wrought-iron piping, special castings, fittings, valves, lead, jute, and for erection and performing the work necessary to complete the pumping station on the Hot Springs Reservation, at Hot Springs, Ark., will be received at this Department until 12 o'clock M., Wednesday, April 30, 1890 when they will be opened. Blank forms of proposal, embracing specifications, together with drawings showing details, may be obtained upon application to the Department, or the Superintendent of the Reservation at Hot Springs, Ark. John W. Noble, Secretary.

◎ FOR SALE. ◎
PULLEY PATTERNS
A set of Iron Pulley Patterns in halves with curved arms. Diameters from eight to twenty by inches, and to forty-eight inches diameter, varying by two inches. 163 in all. No hubs. These have been set aside for some time by our moulding machines, and are offered for sale, low.
Also one set of Hangers; three sets of Mortising Machine; one set of Moulding Machine; two sets of Spoke Lathe; and one set of Upright Shaper Patterns.
THE LANE & BODLEY CO. CINCINNATI, O.

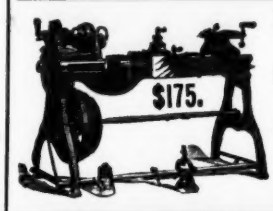
FOR SALE.
A valuable plant of machinery consisting of Milling Machines, Screw Machines, Engine Lathes, Drill Presses, Heavy Drops and Presses, &c., &c., also Tools, Belting and Factory Fixtures, formerly the property of the Howe Sewing Machine Co. Address
THE NEW HOWE MFG. CO.,
Bridgeport, Conn.

WILLIAM JESSOP & SONS, L'D.
MANUFACTORY, SHEFFIELD, ENGLAND. | Chief American Office, 91 JOHN ST., NEW YORK.
JESSOP'S STEEL
BEST TOOL
Gold Medal, Paris, 1889.
Steel in Stock. ALL KINDS OF Importation Orders Promptly Filled.

FACTORIES WANTED
At East Chattanooga, adjoining CHATTANOOGA, TENN., the Hub of the South and center of coal and iron industry. Population in 1880, 13,000; 1885, 25,000; 1889, 55,000. Cheap iron, coal, wood, and labor. Low taxes. River front. Nine railroads, more building, giving cheap railroad and water transportation in all directions. Climate, water supply, and drainage unsurpassed. Free sites and other inducements to manufacturers.
For full particulars, address EAST CHATTANOOGA LAND CO., Chattanooga, Tenn., or L. B. Russell, Sec'y, 96 Summer St., Boston, Mass.


THE DEANE STEAM PUMP CO.,
HOLYOKE, MASS.,
New York, Boston, Chicago, Philadelphia, St. Louis,
Manufacturers of
STEAM and POWER
PUMPS
FOR ALL PURPOSES.
SEND FOR CATALOGUE.

SHEET STEEL
Of Various Qualities and all Gauges,
For Knives, Saws, Scissors, Springs, &c.
CRESCENT STEEL CO.,
64 & 66 SO. CLINTON ST., CHICAGO, ILLS. 136 FIRST AVENUE: PITTSBURGH, PA.
480 PEARL STREET, New York, N. Y.



Improved Screw Cutting Foot and Power **LATHES**
Drill Presses, Shapers, Band, Circular and Scroll Saws. Machinists' Tools and Supplies. Lathes on trial. Catalogue mailed on application.
THE SEBASTIAN-MAY CO., 167 W. 2d St.,
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TOBIN BRONZE
Tensile Strength upwards of 79,000 lbs. per sq. in.
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Anti-Frictional and Non-Corrosive.
CAN BE FORCED HOT.
Rods for pumps and bolts. Yacht shafting. Rolled sheets and plates for pump linings and condenser tube sheets, &c. Ingot metal for car and engine bearings. Spring wire.
ANSONIA BRASS & COPPER CO.,
Sole Manufacturers.
Send for Circular. CHICAGO. NEW YORK.

PATTERN MAKERS' SHOOT PLANE & JACK BOARD.

A. J. WILKINSON & CO.,
Box 3600.
BOSTON, MASS.
SEND FOR CIRCULAR.

ALUMINUM, $2 PER POUND.
THE PITTSBURGH REDUCTION COMPANY, 95 Fifth Avenue, Pittsburgh, Pa., U. S. A., offer commercially pure aluminum at the following rates at Pittsburgh, Pa.:
Lots of 1,000 lbs. and over.....$2.00 ℔ lb
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Metal guaranteed to be equal in quality to the best metal manufactured by any other process.
Prices on sheets, wire, tubes or castings given upon application.

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The Fisher Double Screw Leg Vise.—Warranted stronger grip than any other Vise. Always parallel and cannot be broken.
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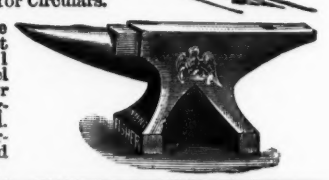
The Eagle Anvil.—Best Cast Steel Face & Steel Horn. Better than any English anvil. Fully warranted and lower price.

"Star" Foot Lathe Swings 9x25 in.
LATHE
Screw Cutting Automatic Cross Feed, etc.
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Catalogue Free of all our Machinery.
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GLEASON MACHINE TOOLS.
Engine Lathes 22 inch to 72 inch swing.
Iron Planers 26 inch to 84 inch wide.
Special Characteristics: Great weight, Great Power and Excellent Workmanship.
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THE CELEBRATED
HEALD & SISCO CENTRIFUGAL PUMPS
Vertical and Horizontal.
COOKE & CO.,
22 Cortlandt St., New York.

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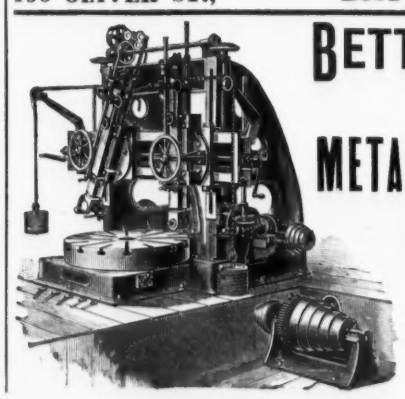
IMPROVED PUMPING MACHINERY | For Every Class of Work | Send for New Illustrated CATALOGUE.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FOR
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AND
Iron and Steel Works
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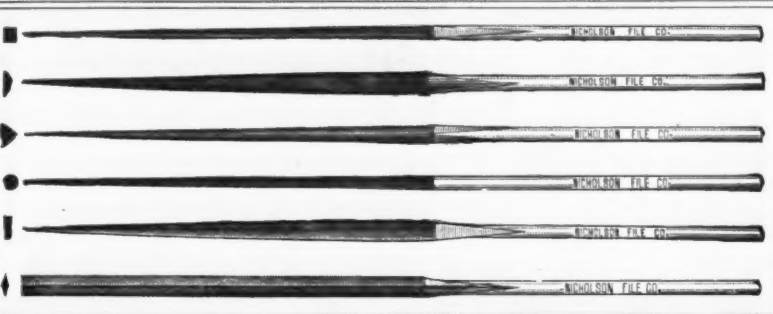

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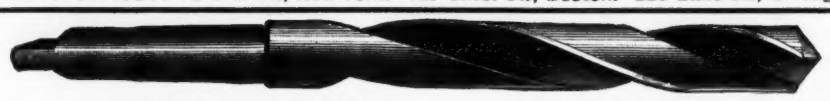
BRANCH OFFICES: 12 Cliff St., New York. 127 Oliver St., Boston. 228 Lake St., Chicago.



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LIGHTNING AND GREEN RIVER SCREW PLATES.

Bolt Cutters, Hand and Power Drilling Machines, Punching Presses, Tire Benders, Tire Upsetters and Other Labor-Saving Tools. Send for Price List.

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Maslin's Patent Pulsator Pump.

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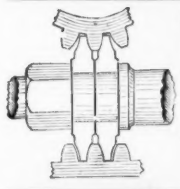
Cheapest and Best Automatic Steam Vacuum Pump. Handling DIRTY and GRITTY LIQUIDS without Wear, Oil or Care. Simple, Economical, Efficient & Durable. Pumping Plants for Contractors, Irrigation, Water Works, Railroads, Mining & General Hydraulic Purposes. Write or call for Circulars. JOHN MASLIN & SON, SOLE MANUF'RS, 165-167 1st St., Jersey City, N. J.



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For cutting the teeth of gears; one Duplex Cutter cuts a pitch from 15 teeth to a rack inclusive. Kept in stock from 4 to 36 pitch and warranted. Circular and price list free.

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CROWELL'S POSITIVE PRESSURE BLOWER,

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Blast and Smelting Furnaces, Forges, Cupolas or any Pneumatic Service where a positive pressure or Vacuum is desired. Any pressure from 1 to 10 lbs. can be obtained, and maintained. Slow running. Minimum of power required.

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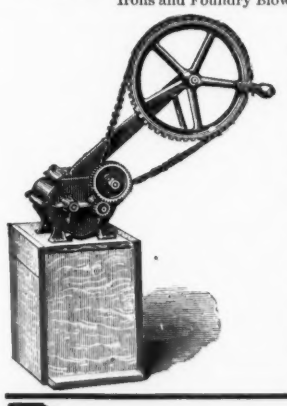
For Blacksmiths, etc. Slow Speed, Positive Blast. Is durable. Compact and Cheap; also Portable Forges, Tuyere Irons and Foundry Blowers.



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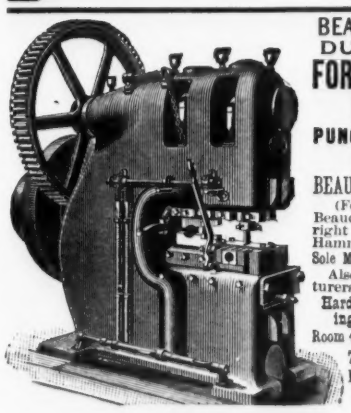

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DROP FORGINGS OF IRON OR STEEL

BEECHER & PECK, NEW HAVEN CONN.

Iron Planers from 16" to 36" wide by any length.

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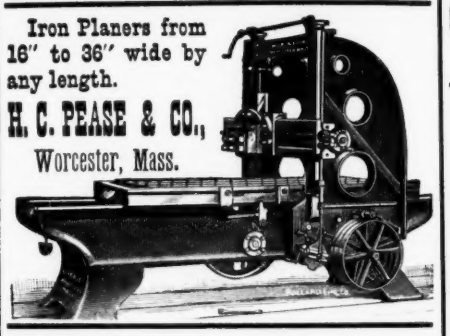

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Following sizes carried in stock:

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For MILLS, FACTORIES, SHOPS, ETC.

For Elevating and Conveying Liquids.
For Emptying Pits, Sinks, Cesspools, etc., and as a Fire Pump.
10 Sizes. $7 to $75. Every Pump warranted.
Write for Descriptive Pump Circular, A

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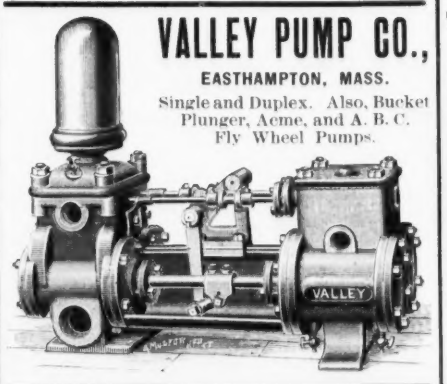
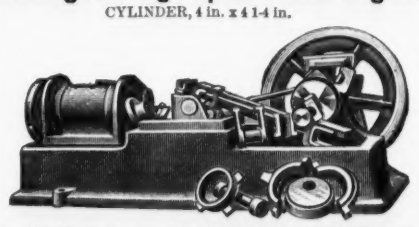
Single and Duplex. Also, Bucket Plunger, Acme, and A. B. C. Fly Wheel Pumps.



Castings for High Speed Steam Engine.

CYLINDER, 4 in. x 4 1-4 in.



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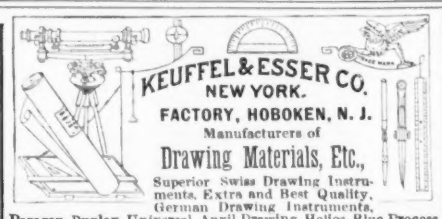
Sets of Castings for Engine illustrated above, with *Cast-steel Shaft, Connecting Rod* and *Rock Shaft*, and *Brass Bearings*, boxed and delivered on boat or cars, in this city, on receipt of $38.00. This includes a *blue print* of working drawing



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Superior Swiss Drawing Instruments, Extra and Best Quality, German Drawing Instruments.

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REDUCED PRICE OF LE COUNT'S HEAVY STEEL DOG

No.	Inch.	Price.
1	3-8	$ .40
2	1-2	.50
3	5-8	.60
4	3-4	.60
5	7-8	.70
6	1	.70
7	1 1-8	.80
8	1 1-4	.80
9	1 3-8	.95
10	1 1-2	.95
11	1 3-4	1.10
12	2	1.20
13	2 1-4	1.35
14	2 1-2	1.45
15	3	1.60
16	3 1-2	1.80
17	4	2.10
18	4 1-2	2.75
19	5	3.25
Full set of 19		$23.60
20 (ext.)	5 1-2	4.00
21 (ext.)	6	5.00

This Dog has a Very Heavy Post, so that if the thread wears a Heavier Screw can be substituted.

Le Count's Heavy Steel Dog.

With Steel Screw. Lathe Made and Hardened. When ordering, state as above, whether a full set or a set of 12, or small set of 8. Users of these dogs prefer them to any other make.

One Small Set of 8—by 1-4 inches to 20 inch, - - $ 6.25
One Set of 12—by 1 4 in. to 2 in. continued by 1-2 in. to 4 in 13 25

HALL DUPLEX STEAM PUMPS.

Send for 1890 Catalogue.

Fire Pump.

HALL STEAM PUMP CO.,

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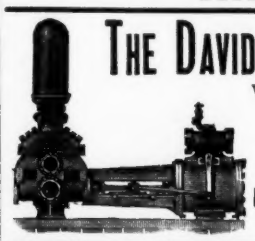
PITTSBURGH. CHICAGO. ST. LOUIS.

Boiler and Pump Combined.

THE DAVIDSON STEAM PUMPS AND PUMPING ENGINES.



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Manufactured by

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BRANCH OFFICES: 77 LIBERTY STREET, NEW YORK. 51 OLIVER STREET, BOSTON.

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For the reason that if you are interested in raising water or other liquids by steam power, we wish to call your attention to the

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CHEAPEST & BEST STEAM PUMP IN THE MARKET. PRICES LOWER THAN ANY OTHER.

More Efficient, Simple, Durable, and more Economical, both as to running expenses and repairs, than any other Steam Pump.

Call or write for our new 96 page Illustrated Descriptive Book containing Full Particulars, Reduced Net Prices, and hundreds of A-1 Testimonials. Mailed Free.

PULSOMETER STEAM PUMP CO., 120 LIBERTY ST., N. Y.

Fitchburg Machine Works,

MANUFACTURERS OF

METAL WORKING MACHINERY

Nos. 13 to 21 Main St., Fitchburg, Mass.

"LITTLE GIANT" IS THE Best Injector

For Feeding all Steam Boilers.

RUE'S • EJECTOR,

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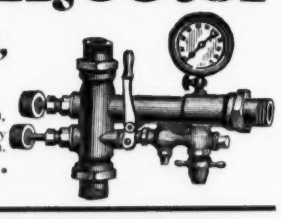

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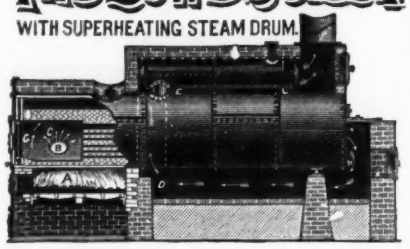

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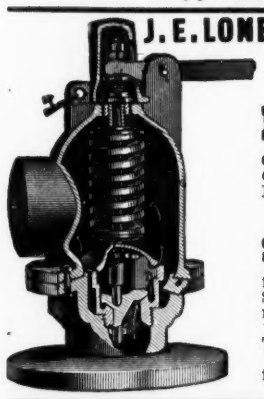

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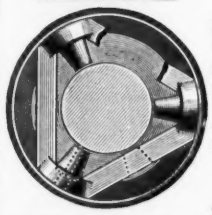

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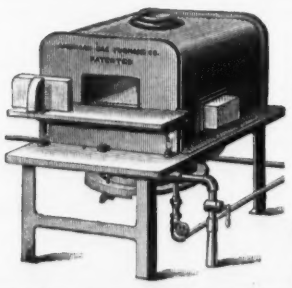

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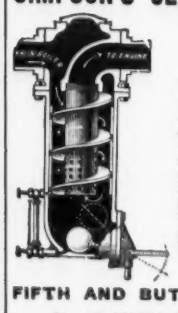

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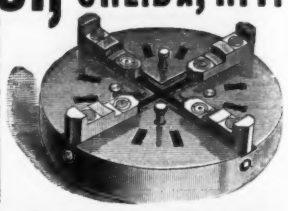

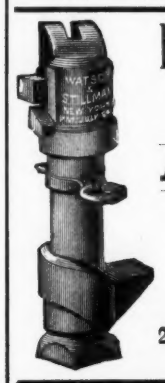

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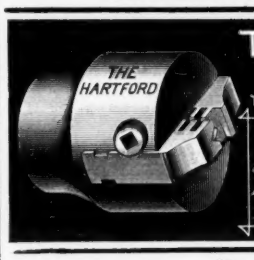

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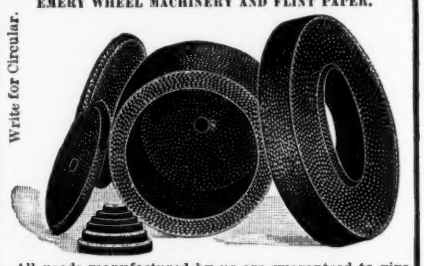

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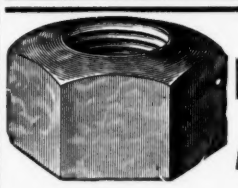

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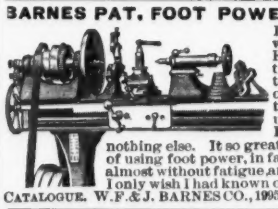

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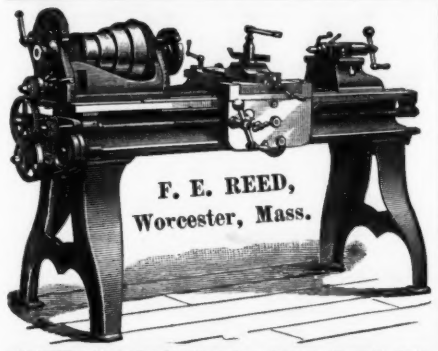

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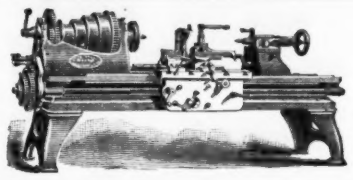

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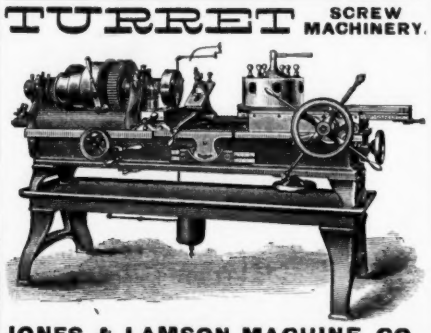

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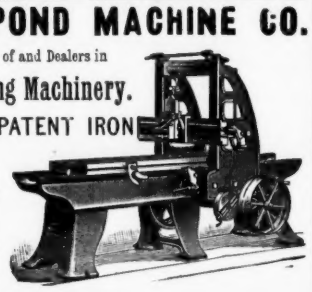

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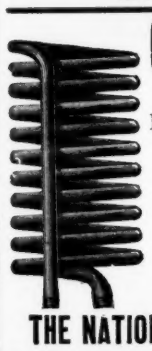

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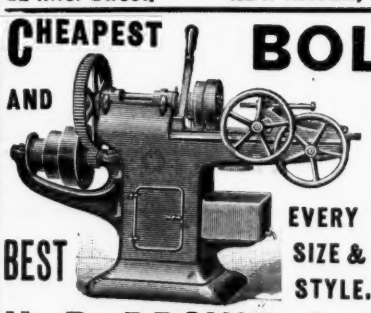

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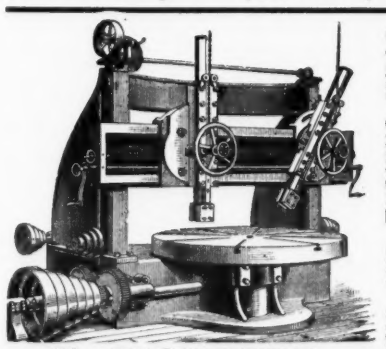

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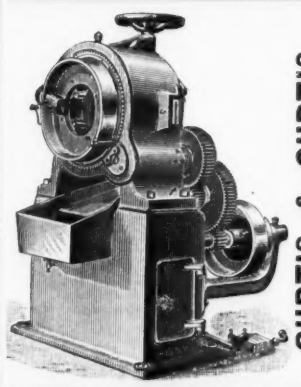

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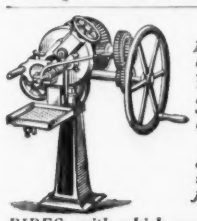

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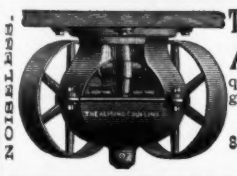

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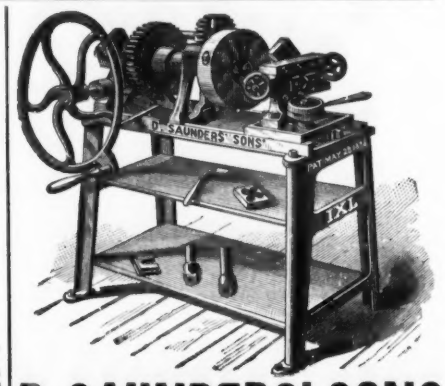

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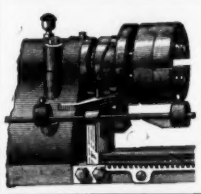
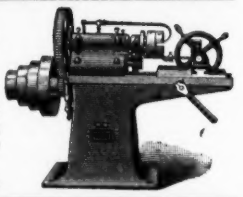
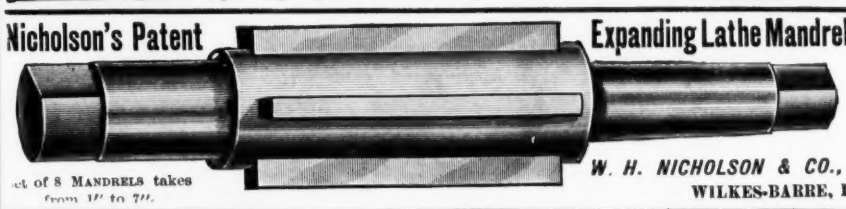


The simplest and most durable machine in existence. The threading head is made entirely of steel. No links, levers, springs, caps, cases, blocks or die rings in or about the head. Separate Heads and Dies Furnished. Write for descriptive circular and price list to
Capitol Mfg. Co., Rees St. near Halsted, Chicago, Ill., U. S. A.



Nicholson's Patent Expanding Lathe Mandrels.



Set of 8 MANDRELS takes from ½" to 7".
W. H. NICHOLSON & CO.,
WILKES-BARRE, PA.

LANSDELL SYPHON
A Cheap & Simple Steam Pump.
Working by direct action of steam. Has no valves or other working parts, and cannot get out of repair, cannot freeze, and will pump ashes, waste, or anything that can enter the pipes. Invaluable as a bilge pump.
MADE IN LEAD OR BRASS FOR ACIDS.
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3/8" **FLEXIBLE METALLIC FILLET**
For Pattern Makers' Use.
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Manufacturers of
Machinists' Tools,
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BLAISDELL ENGINE LATHES.
Great Variety of Styles and Sizes on Hand.
AND ALSO
NEW PATTERN UPRIGHT DRILLS.
HILL, CLARKE & CO.,
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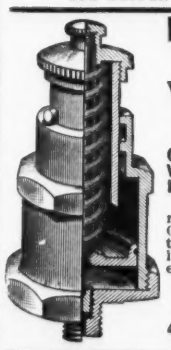

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Will Save Its Cost In Oil alone Several Times per Annum.
SAVES ALSO IN LABOR, AND COST OF COTTON-WASTE. PREVENTS DRIPPING AND SPATTERING.
A POSITIVE FORCE FEED with the most PERFECT REGULATION and GREATEST CONVENIENCE in operation yet attained in any device for the lubrication of machinery. Works equally well in every possible position.
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HERRICK & COWELL,
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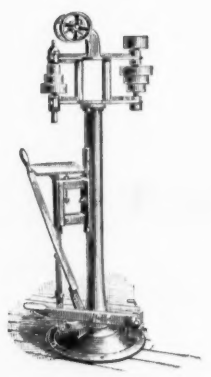

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NEW HAVEN, - CONN.
SEND FOR CATALOGUE.

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Manufacturers of
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SURE GRIP STEEL TACKLE BLOCK.
HALF THE COST of hoisting saved to Machinists, Contractors, Butchers, Builders and others. Admitted to be the greatest improvement EVER made in Tackle Blocks. The cheapest in the market. *Write for Catalogue.*
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Our Steam Damper Regulator is the most perfect and simplest machine in the market. Price, $60 and $100. Any one can apply it. Send for circular to Mason Regulator Co., Boston.

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PHILADELPHIA, PA.
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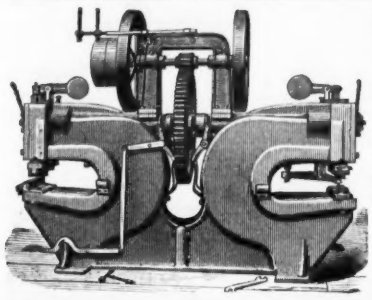
MACHINE TOOLS FOR WORKING IRON AND STEEL,
Improved TURNTABLES for LOCOMOTIVES, CARS and PIVOT BRIDGES.
High Speed Power Traveling Cranes and Hand or Power Swing Cranes, Shafting, Pulleys, Hangers, &c., for transmission of power. Improved Self-Adjusting Injector of 1876. Self-Acting Injector of 1887. Fixed-Nozzle Automatic Injector of 1885.
INJECTORS for ALL CONDITIONS of LOCOMOTIVE and STATIONARY SERVICE



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Double, Single, Angle-Bar, Gang, Horizontal, Twin, Boiler, Spacing, Gate, Multiple, Belt and Steam-Driven
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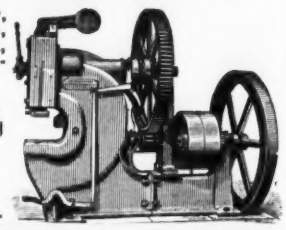
OVER 300 SIZES.
ALSO
Power Cushioned Hammer.
Send for New Catalogue.



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STANDARD OPEN-SIDE PLANER, Sizes 30″, 36″, 48″, 60″, by any desired length.
OPEN-SIDE EXTENSION PLANERS, Sizes 72″ wide x 48″ high x 10′ long, up to 120″ wide x 72″ high x 20′ long.
Open-Side Frog and Switch Planers.
Extra Heavy and Powerfully Geared Up.
The DETRICK & HARVEY MACHINE CO.
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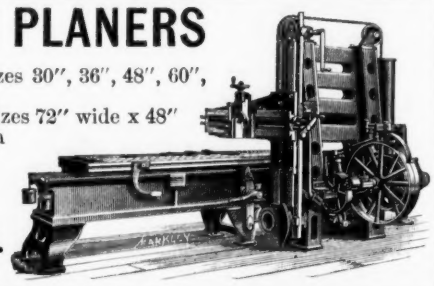

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Manufacturers of
ACME BOLT & RIVET HEADERS,
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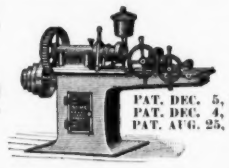
Cutting from 1-8 in. to 6 in. diameter.
Also SEPARATE HEADS and DIES.
FIRST PREMIUM, CINCINNATI CENTENNIAL.



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CAPACITY 10 to 100,000 PER DAY.
8 Different KINDS BRICK MACHINES
THE LATEST and BEST.
PUG Mills, Dump Cars, CLAY Crushers ETC. ETC.
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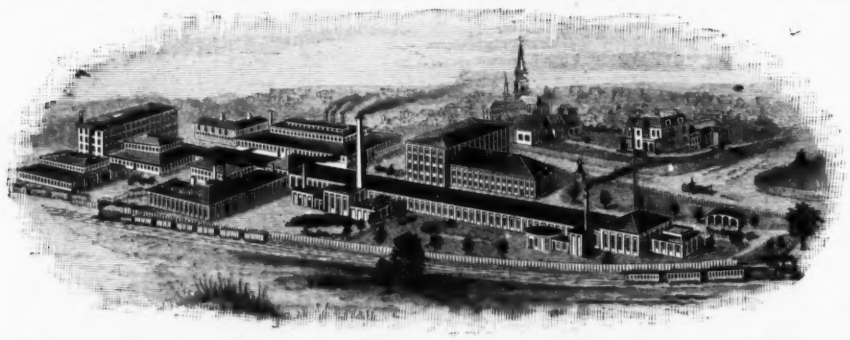
THE FREY, SHECKLER COMPANY, BUCYRUS, O., U.S.A.



The Corliss Steam Engine Co.
PROVIDENCE, R.I.
Incorporated June, 1856; Established by
GEORGE H. CORLISS,
INVENTOR OF THE CELEBRATED
"CORLISS ENGINE."
DESIGNER & BUILDER OF THE FAMOUS
"CENTENNIAL ENGINE",
Exhibited at the Philadelphia Exposition, 1876.

These works have been fully equipped, at great cost, with heavy special tools, of his invention, for them anufacture of this perfected engine, which is a guarantee of superiority in workmanship, and interchangeability of parts never before attempted in the line of steam machinery.

The public will understand that we have no relations with American or European builders of so-called "Improved Corliss Engines," and that the final and perfected Engine of Mr. George H. Corliss, embodying his latest ideas, is to be obtained exclusively at our works.

ALSO MANUFACTURERS OF THE

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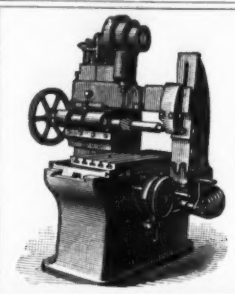
Especially adapted for compound and triple expansion engines requiring superheated steam and at very high pressure.



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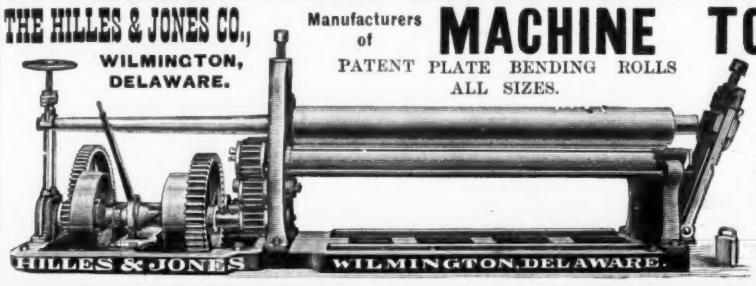
Manufacturers of **MACHINE TOOLS.**
PATENT PLATE BENDING ROLLS
ALL SIZES.
FOR
Boiler Makers, Bridge Builders, Ship Builders, Railroad Shops, Locomotive and Car Builders, Etc., Etc.



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FORGING AND WELDING BY PETROLEUM AIR BLAST.
ALL OIL BELOW BURNERS! NO SMOKE, DIRT, OR ASHES!
Represented by WILLIAM PICKETT, SON & CO., 170 Lake St., Chicago; W. S. COLLINS, 171 Broadway, New York. CHILION JONES, Gananoque, Can. G. M. SMITH, Los Angeles, Cal. KALAMAZOO SPRING AND AXLE CO., Kalamazoo, Mich. C. S. BARROWS, 46 Wade Building, Cleveland, Ohio. GILBERT & BARKER MFG. CO., General Agents for the United States, Springfield, New York and Boston.
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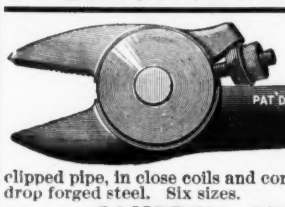
☞ We will replace in Stock or Mutual Companies any Insurance canceled on account of using this System, when installed according to our plans.



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Quick and handy in adjustment. Invaluable for work on clipped pipe, in close coils and corners that cannot be reached with other wrenches. Made entirely of drop forged steel. Six sizes.
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STEEL CASTINGS
FROM 1-4 TO 15,000 LBS. WEIGHT.
True to pattern, sound, solid, free from blow-holes and of unequaled strength.
Stronger and more durable than iron forgings in any position or for any service whatever.
60,000 CRANK SHAFTS and 50,000 GEAR WHEELS of this steel now running prove this.
Crossheads, Rockers, Piston Heads, etc., for Locomotives.
STEEL CASTINGS of every description.
Send for Circulars and prices to
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CASTINGS
Rough and finished to order. All kinds of castings in green or dry sand and loam. Large variety of gear and pulley patterns. Soft castings for finishing. *Patterns made to order.* Parties requiring work are invited to correspond with us before buying elsewhere. Estimates submitted on application.
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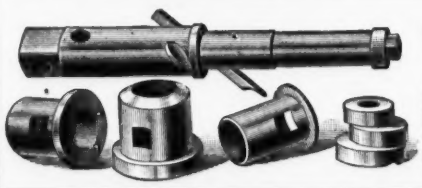
3RD and WALNUT STS., ALLENTOWN, PA.



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For removing Flues from Locomotive and Stationary Boilers. One man can cut five hundred (one end) in a day. In use in the leading Railroad Shops of the country. Combination Cutter for removing 2 in., 2 1-4 in., 2 1-2 in. and 3 in. Flues, $50. Sent on approval to Railroad Co.'s. Liberal Discounts to the Trade.
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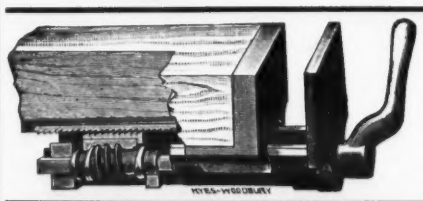

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For Pattern Makers and Wood Workers.
WYMAN & GORDON,
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DROP FORGINGS.

HUGO BILGRAM,
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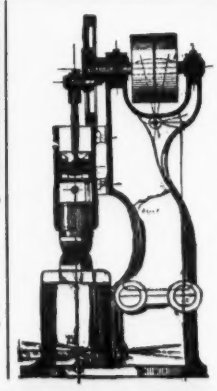
Maker of all kinds of
MACHINERY.
Special facilities for Accurate Work.
Bevel Gears cut theoretically Correct.



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described in the reading columns of number 7, Feby. 13, 1890, of the American Machinist, is to be sold. Full particulars are given on application by
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BALL AUTOMATIC CUT-OFF ENGINES,
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The characteristics of these Engines are Beauty of Design, Superior Finish, Limited Feet in Space required, Economy of Fuel, Perfection of Regulation.
CHARLES R. VINCENT & CO.,
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NEW TANGYE BUCKEYE AUTOMATIC CUT-OFF ENGINES.

In Use, Over 2,500.

25 to 1,000 H. P.

These engines are the combined result of long experience with automatic cut-off regulation, and most careful revision of all details. They are designed and constructed for heavy and continuous duty at medium or high rotative speeds. Highest attainable Economy in Steam Consumption and superior regulation guaranteed. Self-contained Automatic Cut-off Engines 12 to 100 H. P. for driving Dynamo Machines *a specialty*. Illustrated Circulars, with various data as to practical Steam Engine Construction and performance, free by mail. **Address, BUCKEYE ENGINE CO., Salem, Ohio.**

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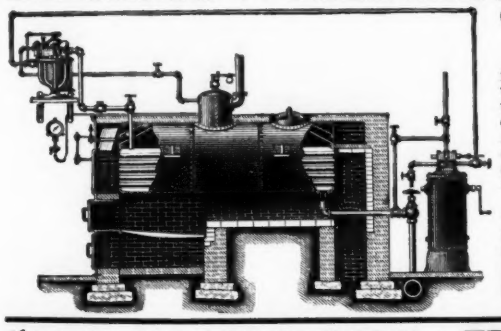
Sole Licensees and Manufacturers for New Jersey (South of Trenton), Eastern Pennsylvania, Delaware, Maryland and Virginia.

BLESSING'S WATER CIRCULATOR AND PURIFIER



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Automatically takes water from the boiler, filters, it and returns it in pure condition, thus removing scale-making impurities from the water, and maintaining a free and steady circulation. Combines the well-known Albany Steam Trap with a Filter of novel construction, which has no rival in point of simplicity, facility for cleaning, and assurance against clogging of sand valve.

Send also for Circulars of Albany Steam Traps, Blessing's Renewable-Seat Stop and Check Valves, Pump Governors, Water Circulators and Purifiers, etc.

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OVER 25,000 ENGINES SOLD.

HORIZONTAL "Otto" Gas Engines.
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COMBINED "OTTO" GAS ENGINES AND PUMPS.
COMBINED "OTTO" GAS ENGINES AND DYNAMOS.

Consume 25 to 75 Per Cent. Less Gas than ANY other Gas Engine doing the same work.

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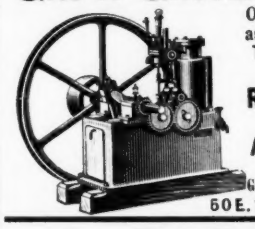

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1 No. 3 Brown & Sharpe Universal Milling Machine, with box of tools and lot of Extra Cutters, second-hand, good as new.

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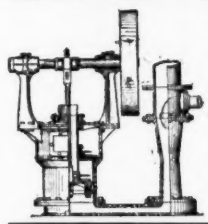

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CONOVER & CO.,
CONSULTING AND MECHANICAL ENGINEERS
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No Air Locks 15 to 50 per cent fuel saved or equal amount of power gained. Runs with same economy as engine. Adapted to all kinds of Engines. *Send for Circular.*

STEAM HEATING.

Barnard's Condensing System will accomplish the following desirable features:

Saves Coal, Perfects the Circulation, Prevents all Noise, Prevents Freezing, Uses Exhaust Steam if any, without back pressure, will work at any pressure of steam, high or low. Has no Machinery needing care. Is adapted to Private Houses, Flats, Office Buildings, Hotels, Factories, etc.

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25 Different Styles and Sizes.

HILL, CLARKE & CO.,
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NEW AND IMPROVED MILLING MACHINE.

☞ Note the following new features:
☞ Overhanging arm removed without taking off the sleeve.
☞ Sleeve for the overhanging arm and the column cast in one piece.
☞ All movements operated from front of machine instead of under the table.
☞ Long bearings. Long and wide tables.
☞ Power feed entire length of table.
☞ Large spindles, hollow their entire length.
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☞ Large cones, wide belts.
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☞ Built either plain, back geared or universal.
☞ Write for prices, with cuts and full descriptions.

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See advertisement, page 16.

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15-in. Friction Shaper, Hendey.	"
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24-in. Shaper, Bridgeport.	New.
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20 in. x 8 ft. " " W., L. & Co.	Good.
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32 in. x 16 ft. " " F. & S.	New.
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No. 3 National Bolt Cutter.	New.
No. 3 Brown & Sharpe Universal Miller, with set of Tools, lot of Cutters, &c.,	Good as new.
1 No. 37 E. W. Bliss Co. Power Press,	A 1 order.
1 X. L. Saunders Pipe Machine.	A1 order.

Cold Rolled Shafting in stock, all sizes.

Full line of new Machinery. Write for what you want.

Send for our list of new and second hand tools for sale.

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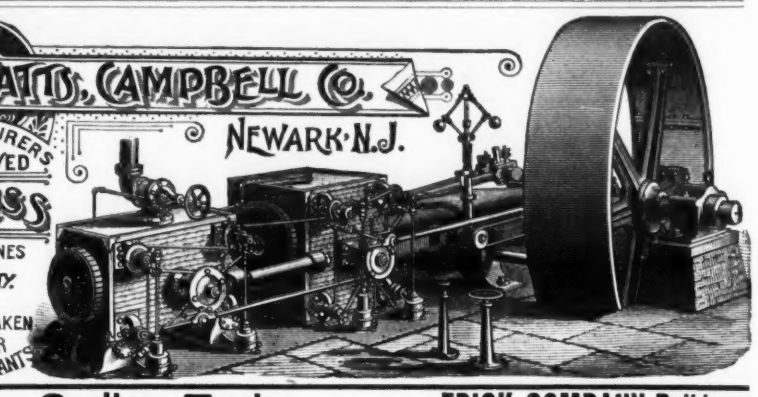
72 Warren St., and 62 College Place, New York.

THE WATTS, CAMPBELL CO.

MANUFACTURERS OF IMPROVED CORLISS STEAM ENGINES IN FULL VARIETY.

NEWARK, N.J.



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Eclipse Corliss Engine.

FRICK COMPANY, Builders,
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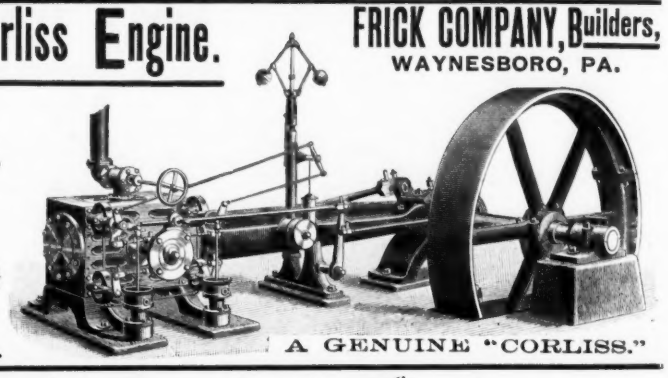
NON-CONDENSING, CONDENSING COMPOUND.
40 TO 1,000 H.P.

Send for Circulars.

ICE-MAKING AND REFRIGERATING MACHINERY.

Send for Special Circular.



A GENUINE "CORLISS."

Bullock-Corliss Engines.

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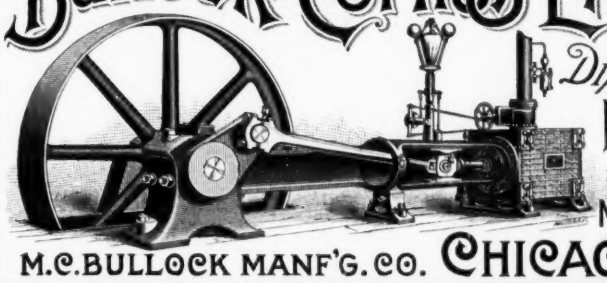

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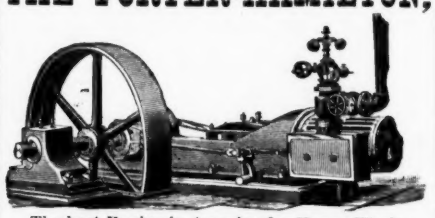

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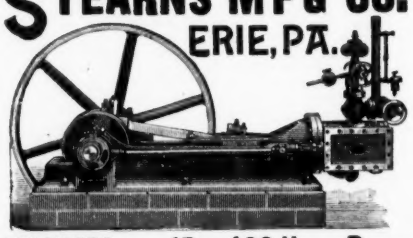

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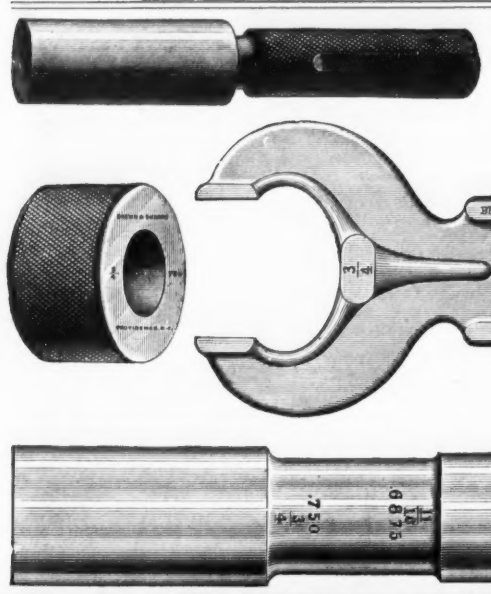

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